TechLaw
Quality & Integrity

1211 H Street, Suite E
Sacramento, CA 95814-1912
(916) 497-0438
(916) 497-0445 FAX
www.techlawinc.com

November 23, 2004

Mr. Lewis Mitani, SFD-8-3
Federal Facilities Cleanup Branch,
Department of Defense and Pacific Islands Section
U.S. Environmental Protection Agency, Region IX
75 Hawthorne Street
San Francisco, CA 94105

Subject: Contract No. 68-W-02-052 / WA No. 052-04-09WQ
Hawai'i Sites Work Assignment, Revised Work Plan Outline, Oahu Sugar Site, Waipio Peninsula, Oahu, Hawai'i

Dear Mr. Mitani:

Enclosed is TechLaw's Revised Work Plan Outline, Oahu Sugar Site, Waipio Peninsula, Oahu, Hawai'i (the Revised Work Plan Outline). The Revised Work Plan Outline presents two parts to address the contamination at the Oahu Sugar Site. The first part addresses steps needed to implement an interim remedy. The interim remedy is an interim cover, and several options are presented for covering the site. In addition, a limited investigation is proposed to support the design of the interim cover by further defining the extent of soil contamination exceeding regulatory industrial screening levels. The interim remedy is intended to prevent runoff of contaminated sediment or surface water from the site and to prevent exposure of trespassers or ecological receptors to site contaminants by direct contact with surface soils. It does not address contaminants that may have already reached Walker Bay via surface water runoff, sediment migration and deposition, or groundwater migration. Initial screening eliminated consolidation as an option at this time, based on comparison of interim cover costs versus costs for vertical extent definition, excavation, confirmation sampling and laboratory analysis.

The interim remedy and limited investigation are based on data presented in the Remedial Investigation (RI) Report, Former Pesticide Mixing Plant, Waipio Peninsula, prepared by BEI Environmental Services (BES) and dated October 25, 2002. It is acknowledged that the RI Report does not contain all elements of a CERCLA RI Report because the site to date has been addressed under a Hawai'i State Department of Health (DOH) Administrative Order. However, the RI data have been validated and appeared to be usable. The screening levels appeared to be adequate to support selection of an interim remedy. The previous RI Report incorporates the comment from Mr. Mike Miyasaka of DOH, that 10 parts per billion (ppb) 2,3,7,8-tetrachloro-dibenzo-*p*-dioxin toxicity equivalent (TEQ) should be considered a screening level for collection of subsurface samples, not an action level. However, the 10 ppb dioxin TEQ screening level is consistent with the 5 to 20 ppb TEQ starting point for cleanup levels at non-time critical removal industrial/commercial sites discussed in OSWER Directive 9200.4-26, dated April 13, 1998. As we have discussed previously, these levels are higher than the dioxin TEQ 2004 Region IX Industrial Preliminary Remediation Goal (PRG) of 0.016 ppb. Regulatory criteria in the RI Report for the other contaminants in soil were based on DOH Tier 1 Action Levels (for a site with drinking water not threatened and less than 200 centimeters annual rainfall) and Region IX Industrial PRGs (EPA, 2000). For groundwater, the regulatory criteria were the Hawai'i State Contingency Plan Saltwater Water Quality Standards (acute and chronic).

The second part of this Revised Work Plan Outline presents the steps needed to conduct a complete Remedial Investigation/Feasibility Study (RI/FS). The Revised Work Plan Outline for this part of the investigation uses non-detectable concentrations for semi-volatile organic compounds (SVOCs), pesticides, and dioxins/furans, and background concentrations for metals for defining the extent of contamination. Background concentrations for metals have not been established for the Oahu Sugar Site, and the Revised Work Plan Outline states that these background concentrations must be established with regulatory input and approval. Further, we have assumed that wells MW-2 and MW-3 will be preserved during the construction of the interim remedy and will be available for monitoring. Part 2 of this Revised Work Plan Outline was designed to support a human health risk assessment assuming a residential land use scenario, and an ecological risk assessment considering transport of contamination to Walker Bay.

Data from both parts of the Revised Work Plan Outline will be used in conjunction with the previous RI Report (BES, 2002) to implement a final remedy. The steps outlined in both parts present a framework for a complete RI/FS Work Plan, which will be expanded and completed by the responsible party or parties.

This Revised Work Plan Outline has been forwarded to you through electronic mail (via Internet) in WordPerfect® Version 6/7/8/9/10/11 format, plus a separate file in pdf format of the figures. A hard copy of the Revised Work Plan Outline is also attached to this letter. TechLaw understands you will review and augment the evaluation at your discretion.

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Thank you for the opportunity to provide U.S. EPA with technical oversight services for the Oahu Sugar Site. Should you have any questions or comments, please contact the TechLaw Site Manager Rich Howard at (916) 497-0438.

Sincerely,

Richard J Howard
for

Indira G. Balkissoon
Regional Manager

DC:RH:IB:sm

cc: Patricia Brown-Derocher/Central Files, TechLaw, Inc.

PEARL HARBOR NAVAL COMPLEX
Oahu, Hawai'i

Revised Work Plan Outline, Oahu Sugar Site
Waipio Peninsula, Oahu, Hawai'i

Submitted to:

Mr. Lewis Mitani
EPA Work Assignment Manager
U.S. Environmental Protection Agency
Region IX SFD-8-3
75 Hawthorne Street
San Francisco, California 94105

Submitted by:

TechLaw, Inc.
90 New Montgomery Street
Suite 1010
San Francisco, California 94105

EPA Work Assignment No.	**052-04-09WQ**
Contract No.	**68-W-02-052**
EPA WAM	**Lewis Mitani**
Telephone No.	**(415) 972-3032**
TechLaw Site Manager	**Rich Howard**
Telephone No.	**(916) 497-0438**

November 23, 2004

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FIGURES

1.0 INTRODUCTION FOR THE REMOVAL ACTION AND INTERIM COVER

This Revised Work Plan Outline describes the requirements necessary to implement a Removal Action (RA) at the Oahu Sugar Site on the Waipio Peninsula, Oahu, Hawai'i. A limited investigation will be conducted to define the lateral extent of contamination greater than industrial screening levels. Once the extent of contamination has been defined, contaminated soils above the cliff in the eastern portion of the site will be excavated and spread over the western portion of the site (below the cliff). An interim remedy (interim cover) will then be constructed over the contaminated area in the western portion of the site. The interim cover is intended to prevent exposure of trespassers or ecological receptors to site contaminants by direct contact with surface soils. It does not address contaminants that may have already reached Walker Bay via surface water runoff, sediment migration and deposition, or groundwater migration. The interim cover is expected to have a life span of approximately 5 years.

Before the responsible party(ies) prepares a work plan for this RA, an Action Memorandum will be required. The Action Memorandum will include all required information outlined in EPA guidance OSWER directive 9360.3-01 (EPA, 1990). The Removal Action Work Plan (RAWP) submitted by the responsible party(ies) will include a Sampling and Analysis Plan (SAP) and a Health and Safety Plan (H&S Plan). Required tasks to be included in the SAP are outlined in the following sections. Requirements for a site-specific H&S Plan are not discussed in this Revised Work Plan Outline; however, an H&S Plan is required. Upon completion of this limited investigation, a design document will be issued describing the interim cover (see Section 3.4).

2.0 BACKGROUND

The Oahu Sugar site occupies approximately 3.5 acres on the Waipio Peninsula near Waipahu, Oahu, Hawai'i (Figures 1 and 1A). The site was leased by the Oahu Sugar Company from the U.S. Navy. The site was used until approximately 1979 to mix pesticides and fertilizer solutions, which were then loaded into backpacks, trucks, or airplanes for application into the surrounding sugar cane fields.

The western portion of the site, approximately 90 percent of the area, is about 5 feet above mean sea level. This portion of the site is cut by an approximately 4 foot deep unlined drainage ditch that runs north/south through the site. The eastern 10 percent of the site rises to approximately 20 feet above mean sea level, above the limestone (calcareous reef deposits) cliff shown on Figure 2. The soils in the western part of the site consist of alluvial soils (Mamala stony silty clay loam), with some reported additions of dredged sediment and fill, including debris, trash, and off-site soils. The soils on top of the cliff developed in basaltic alluvium on top of coral limestone.

Groundwater is present between 3.5 and 7.5 feet below ground surface (bgs), on the lower portion of the site. It is tidally influenced, and the western portion of the site is reportedly inundated at high tide. During the RI, the groundwater flow direction was found to be southerly at a gradient of 0.02. It is likely that groundwater flow direction is variable due to flat gradients and tidal fluctuation.

Surface water, which was not discussed in the previous investigation, appears to flow generally to the west and south. The slope of the ground surface appears to be less than 1 percent, based on the surface elevations of only two wells (MW-1 and MW-3). The drainage ditch, which has a berm along its eastern edge appears to interrupt the westerly flow of surface water. Silt curls were observed against the berm by the northern portion of the ditch (near sampling location 24 on Figure 2), indicating ponding and sediment deposition. The ditch itself flows north to south. It was apparently built to drain the former runway, so at least a portion of the area west of the ditch drains to the east into the ditch, but the areas closest to Walker Bay are assumed to drain into the bay.

The primary release mechanism is believed to be spillage onto surface soils during pesticide and fertilizer mixing and loading, and possibly spillage from former aboveground storage tanks (ASTs). These spills then percolated through surface soils into subsurface soils and groundwater, primarily in the vicinity of the ASTs. Secondary releases from surface water and sediment runoff and from airborne dust transport are also assumed to occur.

A preliminary Remedial Investigation (RI) was conducted at the site in response to Hawai'i State Department of Health (DOH) Administrative Order Number CH 98-001 (issued on January 27, 1998). The RI Report prepared for the site by BEI Environmental Services (BES) (BES, 2002) on behalf of the Oahu Sugar Company has been used as the primary source of information for this Revised Work Plan Outline. The RI Report focused on a comparison of the data with industrial screening levels. For soils, 10 parts per billion (ppb) 2,3,7,8-tetrachloro-dibenzo-*p*-dioxin toxicity equivalent (TEQ) was used for dioxins/furans; for other contaminants in soil, the industrial screening levels were DOH Tier 1 Action Levels (for a site with drinking water not threatened and less than 200 centimeters annual rainfall) and Region IX Industrial Preliminary Remediation Goals (PRGs; EPA, 2000). For groundwater, the industrial screening levels were the Hawai'i State Contingency Plan Saltwater Water Quality Standards (acute and chronic).

During the RI, samples of soil, groundwater, and sediment were collected for analysis (Figure 2). The samples were analyzed for dioxins/furans, semi-volatile organic compounds (SVOCs), organochlorine (OC) pesticides, metals, and chlorinated herbicides, although not all analytes were run for all of the samples collected.

The conceptual site model (CSM) includes complete exposure pathways to human trespassers and ecological receptors (Figure 3). Although a seven-foot high fence surrounds the site, repaired holes in the fence and evidence of human traffic inside the fence (bicycle tire tracks) were observed during a site visit on September 30, 2003. In addition, there is some uncertainty on the lateral extent of contamination, which may extend outside the fence. The primary exposure pathway is direct contact with surface soils, and the site currently is also susceptible to surface runoff and runoff via a drainage ditch that bisects the site, with transport of contaminated sediment into Walker Bay.

Concentrations of diesel-range petroleum hydrocarbons and volatile organic compounds were non-detect or below action levels. As a result inhalation of vapors is not considered a significant exposure route. The primary contaminants are semi-volatile and non-volatile compounds that generally have a high affinity for soils and soil organic matter and low solubility in water (pentachlorophenol [PCP] is sparingly soluble, about 14 milligrams per liter). The largest lateral extent is shown by dioxins/furans in surface soils. The dioxins/furans were likely spilled directly (as an impurity in PCP) or moved on the surface by foot and vehicle traffic and sediment detachment, migration and deposition. The PCP and other pesticides, polynuclear aromatic hydrocarbons (PAHs), and one metal, lead, at the site have much more limited extent above screening levels than dioxins/furans and are generally contained within the lateral extent of dioxins/furans above screening levels. (The exception is sampling location 9, which has dioxins/furans below screening levels and PAHs above screening levels). The subsurface detections of contaminants above screening levels are limited to three sampling locations (12, 19 and 21). Contaminants were detected in groundwater samples from monitoring well MW-3 completed near sampling location 19, but not in two other monitoring wells (MW-1 and MW-2, Figure 2). However, the presumed east to west direction of groundwater flow used to determine the location for "downgradient" well MW-1 was contradicted by a southerly groundwater flow direction during the first sampling event at these wells. This distribution of contaminants is consistent with a CSM of surface releases and slowly mobile contaminants. The extent of contamination has not been well defined and requires additional characterization.

The discharge point(s) from the drainage ditch bisecting the Oahu Sugar site and the areas potentially impacted by sheet flow from the site have not yet been identified, but contamination in Walker Bay has been identified. Three sediment samples were collected as part of the Pearl Harbor Sediment Study in Walker Bay at areas potentially within complete migration pathways from the Oahu Sugar facility (Earth Tech, 2004). Dioxins and pesticides were detected at these three locations. The highest concentrations of DDTs in Walker Bay sediments were detected in sample location 3kz, in shallow water near the Oahu Sugar facility. Similarly, the highest concentrations of dioxins/furans (particularly total 2,3,7,8-tetrachloro-dibenzo-*p*-dioxin [2,3,7,8-TCDD] and total dioxins) were also detected at this location. The highest concentrations of total DDTs in Walker Bay sediments ranged from 8 micrograms per kilogram (μg/kg) at sample location 3kx to 107.5 μg/kg at sample location 3kz, in shallow water near the Oahu Sugar facility. Similarly, the total 2,3,7,8-TCDD toxicity equivalent (TEQ) in sediment ranged from11.7 μg/kg at location 3ky, to162 μg/kg at location 3kz.

3.0 SCOPE AND OBJECTIVES FOR THE REMOVAL ACTION AND INTERIM COVER

This Revised Work Plan Outline presents a framework for a full RAWP, but elements of the RAWP will need to be specified by the party (or parties) performing the work. The interim remedy for this RA is an interim cover, and several options are presented in Section 3.4 for covering the site. A sampling plan to identify the area that will be covered by the interim remedy is presented in Section 3.1. The ultimate objective of the limited investigation and interim cover are to provide a cost-effective method of reducing risk to human and ecological receptors at the Oahu Sugar site, pending implementation of a final remedy (in approximately 5 years) under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

3.1 Field Work Plan Elements for the Removal Action and Interim Cover

The RAWP for Oahu Sugar site will include two field tasks to complete the objective of the RA. These tasks are a topographic survey and soil sampling and analysis. These requirements will be described in detail in the RAWP issued by the responsible party, and will follow EPA guidance (EPA, 2000b).

The topographic survey will be performed to confirm and refine the CSM. The topographic survey will identify areas currently contributing surface water runoff to the drainage ditch, and areas contributing surface water runoff directly to Walker Bay. The topographic survey will also support an assessment of the communication between shallow groundwater and the drainage ditch, help identify where the interim cover will be located, and support the design of the final remedy.

Soil sampling and analysis is required to better define the lateral extent of contamination in the western portion of the site. The vertical extent of contamination in this area has not been fully defined, but is not necessary to determine the lateral boundaries of the interim cover. The vertical extent of contamination will be defined during a complete RI. Soil sampling and analysis will also be conducted above the cliff, which consists of approximately 10% of the site. Surface and subsurface contamination above the cliff was previously identified in the RI Report (BES, 2002). The lateral extent of contamination needs to be defined in this area to determine how much soil must be excavated and moved down to the western portion of the site to be included under the interim cover. During the RI, subsurface soil samples were collected and based on those results, soil will be removed to at least 4 feet bgs. (Sample location 12/12A contained pentachlorophenol at concentrations greater than industrial screening levels in the deepest sample collected from this location at 2.5-3 feet bgs. Sample location 13 did not report SVOCs greater than industrial screening levels in the deepest sample collected from this location at 3-3.5 feet bgs.) Once the extent above the cliff has been defined and the contaminated soil has been excavated, confirmation soil samples will be collected to verify that all contaminants with concentrations exceeding industrial screening levels has been excavated, moved to the western portion of the site, and included under the interim cover.

Thirteen surface soil sample locations are needed. Eight samples are recommended in the western portion of the site and four above the cliff to define the lateral extent of contamination. One sample is also recommended downstream in the drainage ditch, south of the fence (only one sample was previously collected in this ditch). Table 1 presents the rationale for each proposed sample location. Figure 4 presents the proposed sample locations and the preliminary extent of soil contamination greater than industrial screening levels. This area was estimated using data from the previous RI Report (BES, 2002).

In addition, all soil samples will be analyzed for atrazine, simazine, paraquat and diquat. The analytical method used by BES in the previous RI to evaluate herbicides would not detect these contaminants of potential concern (COPCs), which were known to have been used in the cultivation of sugarcane. Atrazine is reported to have accounted for up to 50% of all the herbicides used on sugar cane fields in Hawaii (see http://www.environment-hawaii.org/696atra.htm).

Step-out samples may be required in the western portion of the site if the initial samples shown on Figure 4 contain concentrations of contaminants greater than industrial screening levels. Step-out samples will be collected until the extent of contamination has been defined in all directions to less than industrial screening levels. This is to ensure that all contaminants greater than industrial screening levels are included under the interim cover. In addition, lateral step-out and vertical step-down samples may be required from above the cliff to ensure that all contamination greater than industrial screening levels is excavated and moved to the western portion of the site.

3.1.1 Data Quality Objectives

The following sections outline the data quality objectives (DQOs) used to prepare the sampling plan for the limited investigation of the site. The DQOs were prepared according to the most recent guidance (EPA, 2000a, 2000b).

3.1.2 Problem Statement

Concentrations of dioxins/furans, SVOCs, organochlorine pesticides, and metals in soil have been reported greater than industrial screening levels at the Oahu Sugar site. An interim cover has been proposed for this site to protect surface water and prevent contact with human and ecological receptors. However, the lateral extent of the soil contamination needs to be better defined to determine the optimal placement of the interim cover, and to determine how much soil needs to be excavated from above the cliff.

3.1.3 Decision to be Made

Where do the contaminant concentrations exceed industrial screening levels?

3.1.4 Inputs to the Decision

Inputs to the decision are:

- Results from samples collected during the previous RI (BES, 2002);
- Topographic survey;
- Industrial screening levels (2004 Industrial PRGs [EPA, 2004] for SVOCs, pesticides, herbicides, and metals, and OSWER directive 9200.0-26: 10 parts per billion [ppb] starting point for cleanup levels at CERCLA sites for 2,3,7,8-tetrachloro-dibenzo-*p*-dioxin toxicity equivalent [TEQ]; clarification and justification for using the TEQ can be found in Section 6.2 of the RI Report [BES, 2002]);
- Analytical results from this investigation; and
- Geologic results from the RI and from this investigation.

3.1.5 Boundaries of the Study

The horizontal extent (boundary) of contamination above screening levels is the only boundary being investigated. The vertical extent is not needed for the construction of an interim cover. However, subsurface soil samples (step-down samples) may be required above the cliff to define all areas where contaminants exceed industrial screening levels. The lateral and vertical extent is needed to ensure that all contamination greater than industrial screening levels is excavated and moved to the western portion of site. The horizontal extent depends on the contaminants encountered during sampling.

- For SVOCs, metals, herbicides, and pesticides: The boundary is the periphery estimated from points at which all detectable concentrations are less than 2004 Industrial PRGs.
- For dioxin/furans: The boundary is the periphery estimated from points at which the total TEQ for each sample is less than 10 ppb.

3.1.6 Decision Rules

The following decision rule is used to determine whether the surface contamination is adequately characterized in the western portion of the site.

- If the lateral definition of the contaminants is less than 2004 Industrial PRGs for each SVOC, metal, herbicide, and organochlorine pesticide, and a TEQ less than 10 ppb, then the site has been adequately characterized. If this criterion has not been met, then additional sampling (step-out location) is needed.

The following decision rule is used to determine whether the contamination is adequately characterized above the cliff.

- If the lateral and vertical definition of the contaminants is less than industrial screening levels in the initial samples collected, then the area above the cliff has been adequately characterized. If this criterion has not been met, then additional sampling (lateral step-out and vertical step-down) is needed.
- If the lateral and vertical definition of contaminants is less than industrial screening levels in confirmation samples collected after excavation, then no further excavation is needed. If this criterion has not been met, then additional excavation will be required and additional confirmation samples will be collected.

3.1.7 Tolerable Limits on Decision Errors

Analytical data obtained from this investigation must meet specifications for precision, accuracy, representativeness, comparability, and completeness, as defined in a site-specific Quality Assurance Project Plan (QAPP), to be developed by the responsible party.

- Null Hypothesis: the concentrations of contaminants in soil do not exceed the decision criteria (e.g., PRGs, dioxin TEQ, etc.) in the DQOs.

- *False Positive (Rejection) Error* - the concentrations of contaminants in soil are determined to be less than the decision criteria when they are actually higher than these values.

- *Consequence of False Positive Error* - contaminants in soil left uncovered may lead to an unrecognized increase in risk to human health and/or the environment.

- *Tolerable False Positive* - 10% (per U.S. EPA DQO guidance).

- *False Negative (Acceptance) Error* - the concentrations of contaminants in soil are determined to be greater than the decision criteria when they are actually lower than these values.

- *Consequence of False Negative Error* - unnecessary additional investigation would be performed or additional area of interim cover constructed, resulting in greater cost and additional time.

- *Tolerable False Negative Error Rate* - 10% (i.e., the same as the False Positive Error Rate).

3.1.8 Optimize Design for Obtaining Data

A judgmental sampling strategy is employed for the Oahu Sugar site. Previous sampling results were used to the extent possible in the strategy to decide on sampling locations, number of samples, and analytical methods. Initial sampling locations in this sampling plan will be proposed based on the above decision rules and review of previous data. However, lateral step-out and vertical step-down sampling may be required, pending results from the initial sampling locations.

The following approach will be used:

- Place sample locations outside of the preliminary extent of soil contamination greater than industrial screening levels as shown on Figure 4.

- If results from the locations shown on Figure 4 exceed screening levels in the western portion of the site, collect step-out soil samples outward from locations where contaminants exceed decision rules. A nominal step-out distance of 30 feet is proposed for these analytes, although this will be a location-specific decision.

- If results from the locations shown on Figure 4 from above the cliff exceed screening levels, collect step-out and step-down samples outward from locations where contaminants exceed decision rules. A nominal step-out distance of 30 feet is proposed and a vertical distance of 2 feet is proposed.

- After the initial excavation of contaminated soils from above the cliff, confirmation samples will be collected from the bottom and sidewalls of the excavation in accordance with the site-specific QAPP. If results of the confirmation samples exceed screening levels in sidewall samples, an additional 15 feet laterally in the direction of the exceedance will be excavated. If results exceed screening levels in confirmation samples from the bottom of the excavation, an additional 6 inches will be excavated. Confirmation samples will again be collected. This process will be repeated until all contaminant concentrations are less than screening levels.

- No mobile laboratory or field analyses are proposed. However, an effort will be made to coordinate laboratory turnaround time and site sampling such that the sampling crew can return to the site for step-out samples, if indicated by the initial sampling results, while the field work is still proceeding.

3.2 Analytical Matrix

Table 2 summarizes the analytical methods that will be used during execution of this sampling plan. The analytical methods were chosen because they have the proper target analyte list and reporting limits for this investigation. All methods and reporting limit requirements will be presented in the site-specific QAPP. Lower reporting limits are desirable for risk assessment purposes for certain chemicals. Target reporting limits are summarized in Tables 3 and 4 and are based on ecological risk screening criteria. Inorganic criteria were obtained from sources such as U.S. EPA, Consensus Threshold Effect Concentrations (TEC), NOAA, National Ambient Water Quality Criteria, Tier II Secondary Chronic Value Surface Water Screening Benchmarks, Oak Ridge National Laboratory, and U.S. EPA Region 6. Organic criteria were obtained from sources such as Oak Ridge National Laboratory, OSWER, NOAA, U.S. EPA, National Ambient Water Quality Criteria, Tier II Secondary Chronic Value, and Dutch Target Values. Actual method detection limits may be less sensitive depending on available analytical techniques. The responsible party may choose analytical methods with detection limits that differ from the target reporting limits summarized in Tables 3 and 4; however, agreement between U.S. EPA and the responsible party(ies) is needed regarding ecological risk screening criteria and detection limits. Ecological risk screening criteria will exceed method detection limits. Quality assurance/quality control (QA/QC) samples will be collected in accordance with QAPP criteria. Requirements of a site-specific QAPP are not outlined in this Revised Work Plan Outline. However, the site-specific QAPP submitted by the responsible party will follow the EPA Guidance for Quality Assurance Project Plans (EPA, 2002).

3.3 Field Methods, Procedures, and Documentation

The field methods will be presented in a site-specific FSP to be prepared by the responsible party and approved by regulatory agencies prior to the start of field work. A site-specific Health and Safety Plan will also be prepared, but is not outlined in this Revised Work Plan Outline.

The responsible party will stay in regular contact with EPA, including the submission of daily field reports as the field work is progressing. The responsible party will also submit copies of preliminary analytical data used to make decisions regarding the extent of contamination to EPA. EPA will determine if the extent of contamination has been defined and if all contamination above the cliff has been excavated.

Once all contaminated soil has been defined and excavated from above the cliff, the responsible party will issue a design document for the interim cover. The design document will include project staffing, personnel coordination, and a project schedule that describes field activities and reports to support the interim cover. The design document will require EPA's approval before construction of the cover can begin.

3.4 Conceptual Design and Cost Estimate

3.4.1 Conceptual Design

This Revised Work Plan Outline examined seven (7) potential temporary covers for the Oahu Sugar site. The covers were selected based on the threshold criteria that they must be able to prevent incidental direct human contact with the surface soils at the site. The other criteria that were used to evaluate the various covers were:

- Permeability,
- Cost,
- Ease of maintenance,
- Public Acceptance, and
- Waste generation (residuals at the end of the design life).

In addition, two of the potential final covers, which are equivalent to Subtitle D Landfill Prescriptive final covers, may be acceptable as final remedies for the site and the Biosolids cover might be suitable for incorporation into a final isolation remedy.

The remedies examined in this Revised Work Plan Outline are:

- Subtitle D Landfill Prescriptive final cover consisting of a foundation layer, two-feet of low permeability soil (native material amended with imported bentonite), a high density polyethylene (HDPE) geomembrane, and a vegetative soil layer.
- Dust Barrier, consisting of a non-woven geotextile covered with six inches of gravel.
- Asphalt - this would be standard asphalt, though there are proprietary asphalt materials that would provide much more reliable barriers to infiltration.
- Geocomposite Clay Liner 1 (GCL1) - bentonite, to reduce infiltration, bonded to geotextile covered with six inches of gravel.
- Geocomposite Clay Liner 2 (GCL2) - bentonite bonded to a geomembrane (GundSeal) covered with a vegetative soil layer. This cover is equivalent to the Subtitle D Landfill Prescriptive Cover and much less expensive.
- HDPE Geomembrane Cover - Consists of a geotextile cushion between the native materials and the geomembrane with six inches of gravel over the geomembrane. The gravel is used for protection from ultraviolet radiation, which would

otherwise degrade the HDPE liner over time. In a permanent installation, there would probably be a cushion geotextile above the membrane. For a temporary installation, this wasn't considered necessary.

- Biosolids Cover - Biosolids are sanitary sewer treatment plant solids. They have a high organic carbon content and would hence tend to bind tightly to the organic contaminants in the Oahu Sugar Site surface soils and reduce their mobility.

This Revised Work Plan Outline does not examine monolithic covers (usually five to six feet of soil), capillary break covers, or geosynthetic covers from any material other than HDPE (e.g., polyvinyl chloride [PVC], low-density polyethylene [LDPE], visqueen, et cetera). It was felt that the monolithic cover was unsuitable for a temporary cover and the capillary break cover was unsuitable for tropical climates. PVC and LDPE are generally less expensive than HDPE and might be suitable for this application. However, for the purposes of this Revised Work Plan Outline, it did not seem cost effective to examine different materials as it was not felt that the properties of the different materials would impact the decision process. At the detailed design stage, should the temporary cover incorporate a geosynthetic, the designer, presumably familiar with local conditions and the state of practice in the area, may choose to use one of these materials.

3.4.2 Cost Estimate

The costs presented in Table 5 are not meant to reflect total costs in that they do not include many costs that are common to all of the potential covers (design, permitting, mobilization/demobilization, clearing/grubbing, disposal of vegetation, et cetera). Design and maintenance costs are assumed to be about the same for all alternatives except the Subtitle D Prescriptive final cover and GundSeal (GCL2) covers. Design and maintenance costs for these remedies are assumed higher as they might serve as final remedies, and hence the additional cost would be warranted.

3.4.3 Assumptions

1. The additional cost of the Subtitle D Landfill Prescriptive final cover design was assumed to amount to 30% of the materials and installation cost. Maintenance of the Subtitle D landfill for 5 years was assumed to be $3,500 per year for five years (present worth of $16,000)
2. It was assumed that the Subtitle D Landfill Prescriptive final cover and GCL2 remedies, if built, would be permanent. Hence, there is no disposal cost included in the Subtitle D cover.
3. All costs include a 20% contingency.
4. HDPE seams assumed lapped rather than welded (for the small area to be covered, mobilizing a specialty contractor from the mainland was assumed to be cost prohibitive).

A standard geomembrane roll is about 10,000 square feet. Overlapping the membranes by 5 feet effectively reduces the area each roll can cover by about 15%.

5. Area to be covered is 3.5 acres, assuming the entire area within the fence will be covered. A smaller area may be justified by the limited investigation.
6. Costs include disposal of cover materials as Subtitle D waste at $50/ton. It was assumed that the separation layers between the soil and gravel ultraviolet (UV) protection would keep the gravel from becoming contaminated. The GCLs were assumed to require disposal at $50 per ton.
7. Present worth of disposal costs not discounted as it is assumed that disposal costs will rise at the same rate as the applicable discount rate.
8. Subtitle D low-permeability soil layer incorporates 5% imported bentonite.
9. Gravel selected for UV protection because it would be easier to remove than soil (without damaging underlying geosynthetics)
10. The only cost of biosolids is transport and handling, assumed to be $\$5/yd^3$. Without disposal charges, the cost of the biosolids cover is only $38,000. Even if the biosolids could be separated from the contaminated soil, using a geotextile for example, which would somewhat reduce their contaminant fixing properties, it is unlikely that a beneficial reuse for the material could be found given its provenance. Biosolids might make a good foundation layer for a cover system given their high organic carbon content.
11. Soil unit weight: 120 pounds per cubic foot (pcf); asphalt unit weight: 140 pcf; biosolids unit weight: 110 pcf

3.4.4 Unit Costs

Unit costs used in preparing the cost estimates are shown in Table 6. Costs are installed costs. Spreadsheets showing how the costs were calculated are available on request.

3.5 Removal Action Completion Report

The responsible party will submit a Removal Action Completion Report (RACR) upon completion of the installation of the cover, including results of the limited investigation and as-built specifications for the cover. The RACR will follow EPA Close Out Procedures for National Priorities List Sites (EPA, 2000d).

4.0 REFERENCES

BEI Environmental Services (BES), 2002. Remedial Investigation Report, Former Pesticide Mixing Plant, Waipio Peninsula, Waipahu, Hawaii. October 25.

Earth Tech Inc. (Earth Tech), 2004. Draft, Step 7 Baseline Ecological Risk Assessment Pearl Harbor Sediment Remedial Investigation, Pearl Harbor, Hawaii. June 2004.

United States Environmental Protection Agency (EPA), 1988. Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, 540/G-89/004 OSWER Directive 9355.3-01, October.

EPA, 2000a. Data Quality Objectives Process for Hazardous Waste Site Investigations, EPA QA/G-4HW, Final. EPA/600/R-00/007. January.

EPA, 2000b. Sampling and Analysis Plan Guidance and Template, Version 2, Private Analytical Services Used, EPA R9QA/002.1. 2000

EPA, 2000c. Guidance for the Data Quality Objectives Process, EPA QA/G-4. EPA/600/R-96/055. August.

EPA 2000d. Close Out Procedures for National Priorities List Sites, EPA 540-R-98-016. January

EPA 2002. Guidance for Quality Assurance Project Plans, EPA QA/G-5. December.

EPA, 2004. Region 9 Preliminary Remediation Goals (PRGs) Table 2004 Update. October.

5.0 INTRODUCTION FOR THE REMEDIAL INVESTIGATION/FEASIBILITY STUDY

This Revised Work Plan Outline presents steps recommended to implement a complete RI/FS at the Oahu Sugar site. The RI/FS will build on data and information provided in the previous RI Report (BES, 2002), and data gathered during the limited investigation conducted to install the interim cover. Additional data will be collected to fill remaining data gaps in surface and subsurface soil, groundwater and sediment, support human health and ecological risk assessments, and support final remedy selection. Further, this Revised Work Plan Outline includes consideration of contaminant concentrations detected in Walker Bay sediments and potential transport of contamination from the site to Walker Bay.

The major elements of a complete RI/FS, in accordance with CERCLA guidance, are presented below. These elements will be expanded in an RI/FS Work Plan prepared by the responsible party(ies) who will conduct the work.

- Assemble available data
- Conduct community interviews
- Develop a community relations plan
- Conduct field reconnaissance including interviews of former site workers if possible
- Prepare preliminary conceptual site model
- Develop DQOs
- Identify data gaps
- Develop an Applicable or Relevant and Appropriate Requirements (ARARs) list consulting:
    - ✓ Hawai'i Department of Health
    - ✓ City and County of Honolulu
    - ✓ US Fish and Wildlife Service (USFWS)
    - ✓ US Army Corps of Engineers (USACE)
    - ✓ National Oceanic and Atmospheric Administration (NOAA)
- Identify potential regulatory issues
    - ✓ Endangered Species
    - ✓ Wetlands
    - ✓ Cultural resources
    - ✓ Military land use restrictions
    - ✓ Natural resource trustee concerns
    - Develop an SAP consisting of a field sampling plan (FSP), health and safety plan (HSP), and quality assurance project plan (QAPP)
    - Implement SAP to fill data gaps
    - Validate data
    - Identify nature and extent of contamination

- Identify potentially completed pathways
- Prepare community relations materials (e.g., fact sheet, mailing)
- Conduct transport modeling, if necessary
- Refine conceptual site model
- Identify data gaps. If any remain, refine DQOs if necessary and repeat subsequent steps.
- Quantify human health and ecological risks
- State the remedial action objectives
- Identify potential remedial actions, including at least one innovative remedial option
- Assemble remedial alternatives
- Perform treatability studies, if required
- Screen potential remedial actions against the nine National Contingency Plan (NCP) criteria
- Provide a preferred remedy to the remedial project managers (RPMs)

This Revised Work Plan Outline provides expanded discussion of the following key elements of the RI/FS process:

- Assemble available data
- Conduct field reconnaissance
- Prepare preliminary conceptual site model
- Develop data quality objectives
- Identify data gaps
- Develop a sampling and analysis plan
- Quantify human health and ecological risk

While expanded information on each of these topics is provided below, the responsible party(ies) will need to provide additional details to create a complete RI/FS Work Plan.

6.0 SCOPE AND OBJECTIVES FOR THE RI/FS

This Revised Work Plan Outline presents a conceptual framework for an RI/FS Work Plan, but the complete RI/FS Work Plan will need to be developed by the responsible party performing the work. The Revised Work Plan Outline presents steps required to characterize the nature and extent of contamination at the Oahu Sugar site, assess the risks to human health and the environment, and support the final remedy selection. The scope of the Revised Work Plan Outline is built on the assumption that the interim remedy and supporting sampling have been implemented, and the interim remedy covered all concentrations greater than industrial screening levels. Elements of a sampling plan for the complete RI is presented in the following section.

The primary objectives of this sampling plan are to (1) define the lateral extent of site-related soil contamination to non-detectable concentrations (ND) for all COCs (metals will be defined to less than established background concentrations, which will be determined with regulatory input and approval), (2) provide data to support exposure point calculations for current and potential future human and ecological receptors, (3) create a well network to monitor potential discharge to surface water, and (4) provide risk managers with an estimate of ambient concentrations of contamination.

6.1 Field Work Plan Elements for the RI/FS

The RI/FS Work Plan to be prepared by the responsible party for the Oahu Sugar site will include three field tasks. These tasks are needed to meet the objective of the sampling plan and include a site reconnaissance, surface and subsurface soil, sediment and groundwater sampling and analysis, and an aquifer study. These requirements will be described in detail in the RI/FS Work Plan issued by the responsible party.

First, a site reconnaissance is necessary to identify potential ecological receptors and habitat as well as completed exposure pathways. The site reconnaissance will be performed by a team that includes a qualified biologist, with the objectives of identifying (1) the potential presence of special status species, (2) the presence of critical habitat, and (3) the biological setting of the site. The site reconnaissance team will also include an ecological risk assessor to evaluate potentially completed exposure pathways and confirm or refine the conceptual site model. For example, the offsite portion of the drainage ditch that carries surface runoff from the west side of the site to Pearl Harbor was not mapped in the RI Report (BES, 2002) and is a critical component of the conceptual site model. Similarly, additional potential source areas (such as a loading and maintenance area at the end of the runway) may be present.

The second task is soil, sediment, and groundwater sampling and analysis. Table 7 presents the rationale for the proposed sampling locations. Figure 5 presents proposed locations for the five monitoring wells. Additional soil, sediment, and groundwater sample locations are recommended as follows.

- Surface soil samples are recommended to define lateral extent of contamination and provide data to support exposure point calculations for both human and ecological risk assessments.
- Sediment samples are also recommended in Walker Bay, in the drainage ditch and at the outfall of the drainage ditch to Pearl Harbor to assess offsite transport of contaminants with surface water and to support the development of exposure point concentrations.
- Subsurface soil/monitoring well locations are recommended to further define the vertical extent of soil contamination, tidal influence, local

groundwater gradients, and communication between shallow groundwater and surface water in the drainage ditch and Walker Bay.

- Surface soil samples are recommended offsite upwind (northeast) of the site to (1) establish the extent of contamination to ND and ecological screening levels, (2) to reduce uncertainty regarding ambient concentrations, and (3) to support risk management decision-making.

Step-out samples (surface and subsurface) will be collected depending on the results of the soil sampling. Soil samples will be collected if concentrations of COCs exceed ND or ecological screening levels, or if metals exceed background concentrations. Sediment samples will also be collected along the shoreline in Walker Bay immediately west of the site. The samples will be collected from nearshore, subtidal sediments.

The third field task is an aquifer study. The study will include aquifer testing to evaluate aquifer characteristics such as hydraulic conductivity in the shallow aquifer and to support calculation of the seepage velocity. As part of the aquifer characterization, undisturbed soil samples will be collected as the five monitoring well borings are advanced. (It is assumed that the three monitoring wells installed during the RI [MW-1 through MW-3] can be located and are operational.) The soil samples will be analyzed for total organic carbon (TOC) and the effective porosity will be measured to assist in contaminant retardation estimates. The aquifer study will also include a tidal influence assessment to evaluate communication between shallow groundwater and Walker Bay. Groundwater fluctuations will be monitored over several tidal cycles using pressure transducers or other appropriate method. Groundwater elevations will be measured to ensure that there is no bias related to tidal influences.

6.1.1 Data Quality Objectives

The following sections outline the DQOs used to prepare the sampling plan for the RI/FS. The DQOs were prepared according to the most recent guidance (EPA, 2000a, 2000c).

6.1.2 Problem Statement

Concentrations of dioxins/furans, SVOCs, pesticides, chlorinated herbicides, and metals in soil and groundwater have been reported above industrial, residential, and ecological screening levels at the Oahu Sugar site. An interim cover is assumed to have been installed at the source area to protect surface water from contaminated surface runoff and minimize contact with human and ecological receptors. However, the lateral extent of the soil and groundwater contamination needs to be defined to support human health and ecological risk assessments and selection of a final remedy for the site.

6.1.3 Decisions to be Made

Where do the contaminant concentrations exceed ND and ecological risk screening levels?

6.1.4 Inputs to the Decision

Inputs to the decision are:

- Topographic survey
- Site reconnaissance data
- Geologic and hydrologic results from the previous RI (BES, 2002) and from this investigation
- Results from samples collected during the previous RI
- Results from samples collected to define the interim cover boundaries (the limited investigation conducted for the Removal Action)
- Analytical results from this investigation
- Screening levels for human health and ecological receptors

6.1.5 Boundaries of the Study

The horizontal and vertical extent (boundaries) of contamination are being investigated. The horizontal extent depends on the contaminants encountered during sampling. Screening levels must be developed with regulatory input. In general, the area of investigation is the area that includes the site, the area downgradient and downwind of the site defined by contaminant screening levels, and the approximately 5,000 square yard area immediately upwind of the site. For SVOCs, metals, herbicides, dioxins/furans and pesticides, the boundary is the periphery estimated from locations with no detections or background concentrations as established with regulatory input.

The temporal boundary of the study is one year, to capture seasonal variation in groundwater levels and contaminant concentrations. In addition, groundwater elevations will be collected over at least one full tidal cycle to support the aquifer study.

6.1.6 Decision Rules

The following decision rule is used to determine whether the surface contamination is adequately characterized.

- If the lateral definition of the contaminants is ND for each SVOC, metal (less than background), dioxin/furan, herbicide and pesticide, then the site has been adequately characterized. If this criterion has not been met, then additional sampling (step-out location) is needed.

6.1.7 Tolerable Limits on Decision Errors

Analytical data obtained from this investigation must meet specifications for precision, accuracy, representativeness, comparability, and completeness, as defined in a site-specific QAPP, to be developed by the responsible party.

- Null Hypothesis: the concentration of contaminants in soil do not exceed the decision criteria (e.g., ND, background, etc.) in the DQOs.
- *False Positive (Rejection) Error* - the concentrations of contaminants in soil are determined to be less than the decision criteria when they are actually higher than these values.
- *Consequence of False Positive Error* - contaminants in soil are not addressed by the final remedy may lead to an unrecognized increase in risk to human health and/or the environment.
- *Tolerable False Positive* - 10% (per U.S. EPA DQO guidance).
- *False Negative (Acceptance) Error* - the concentrations of contaminants in soil are determined to be greater than the decision criteria when they are actually lower than these values.
- *Consequence of False Negative Error* - unnecessary additional investigation would be performed or additional area considered in the final remedy, resulting in greater cost and additional time.
- *Tolerable False Negative Error Rate* - 10% (i.e., the same as the False Positive Error Rate).

6.1.8 Optimize Design for Obtaining Data

The sampling strategy employed for the Oahu Sugar site will be established by the responsible party(ies) with regulatory input. Previous sampling results will be used to the extent possible in the strategy to decide on sampling locations, number of samples, and analytical methods. Initial general sampling locations in Table 7 were proposed based on a judgmental sampling strategy, the above decision rules, and review of previous data. However, step-out locations may also be identified, pending results from the initial sampling locations.

The following approach will be used:

- Place sample locations outside of the preliminary extent of soil contamination greater than industrial screening levels.
- Install monitoring wells at presumed upgradient and cross gradient locations (at least three wells are anticipated for this purpose). Convert two borings to presumed down gradient monitoring wells south of the source area. One boring will be placed immediately south of the source area, and

one boring will be placed adjacent to the drainage ditch south of the site. These wells are needed to reduce the significant uncertainty regarding the local groundwater gradient and groundwater discharges to surface water.

- Lateral step-out locations to collect soil samples will be located outward from locations where SVOCs, dioxin/furans, herbicides, metals, or organochlorine pesticide results exceed decision rules. A nominal step-out distance of 30 feet is proposed for these analytes, although this will be a location-specific decision.
- Subsurface soil samples will be collected approximately 2 feet deeper than the deepest sample that exceeded the decision rules.
- No mobile laboratory or field analyses are proposed. However, an effort will be made to coordinate laboratory turnaround time and site sampling such that the sampling crew can return to the site for step-out samples, if indicated by the initial sampling results, while the field work is still proceeding.

6.2 Analytical Matrix

Table 8 summarizes the analytical methods that will be used during execution of the RI/FS Work Plan. The analytical methods were chosen because they have the proper target analyte list and often the proper reporting limits for this investigation. All methods and reporting limit requirements will be presented in the site-specific QAPP. Lower reporting limits are desirable for risk assessment purposes for certain chemicals. Target reporting limits are summarized in Tables 3 and 4 and are based on ecological risk screening criteria. Inorganic criteria were obtained from sources such as U.S. EPA, Consensus Threshold Effect Concentrations (TEC), NOAA, National Ambient Water Quality Criteria, Tier II Secondary Chronic Value Surface Water Screening Benchmarks, Oak Ridge National Laboratory, and U.S. EPA Region 6. Organic criteria were obtained from sources such as Oak Ridge National Laboratory, OSWER, NOAA, U.S. EPA, National Ambient Water Quality Criteria, Tier II Secondary Chronic Value, and Dutch Target Values. Actual method detection limits may be less sensitive depending on available analytical techniques. The responsible party may choose analytical methods with detection limits that differ from the target reporting limits summarized in Tables 3 and 4; however, agreement between U.S. EPA and the responsible party(ies) is needed regarding ecological risk screening criteria and detection limits. Preferably, ecological risk screening criteria will exceed method detection limits. Quality assurance/quality control (QA/QC) samples will be collected in accordance with QAPP criteria. Requirements of a site-specific QAPP are not outlined in this Revised Work Plan Outline. However, the site-specific QAPP included in the RI/FS Work Plan submitted by the responsible party will follow EPA Guidance for Quality Assurance Project Plans (EPA, 2002).

6.3 Field Methods, Procedures, and Documentation

The field methods will be presented in a site-specific FSP to be prepared by the responsible party and approved by Regulatory Agencies prior to the start of field work. Sediment sampling methods will be designed to minimize disturbance. A site-specific Health and Safety Plan will also be prepared.

The responsible party will stay in regular contact with EPA, including the submission of daily field reports as the field work is progressing. The responsible party will also submit copies of preliminary analytical data used to make decisions regarding the extent of contamination to EPA. EPA will make the final determination on whether the extent has been sufficiently defined. Once the field work is completed, the responsible party will issue an RI Addendum report discussing the nature and extent of contamination, including a human health and ecological risk assessment, as described in the following sections.

6.4 Human Health Risk Assessment Approach

The human health risk assessment will be completed in accordance with the following current guidance and sources of information:

- U.S. EPA Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual found at http://www.epa.gov/superfund/programs/risk/toolthh.htm#general
- Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites (OSWER, 2002)
- Exposure Factors Handbook (EPA, 1997a)
- U.S. EPA Integrated Risk Information System (IRIS) for toxicity data found at http://www.epa.gov/iris/
- Memorandum: Guidance on Risk Characterization for Risk Managers and Risk Assessors (EPA, 1992) available at http://www.epa.gov/superfund/programs/risk/habicht.htm

The scope of the risk assessment will be established based on the refined CSM and regulatory input. As summarized in the preliminary CSM (Figure 3), the following exposure scenarios will be considered in the risk assessment:

- residents exposed to chemicals in surface soil, sediment, surface water, and fish
- site trespassers exposed to chemicals in surface soil, sediment, and fish
- industrial workers exposed to chemicals in surface soil

The following potential issues will be resolved early in coordination with the Regulatory Agencies:

- determination of background/ambient risks
- methods for assessment of risk due to lead exposure
- exposure assessment methods for fish ingestion

6.5 Ecological Risk Assessment Approach

6.5.1 Introduction

The responsible party(ies) will prepare an Ecological Risk Assessment in accordance with Ecological Risk Assessment Guidance for Superfund (EPA, 1997b) and Guidelines for Ecological Risk Assessment (EPA, 1998).

A Screening-Level Ecological Risk Assessment (SERA) will be prepared according to Steps 1 and 2 (EPA, 1997b) using the preliminary conceptual site model as a starting point (Figure 3). The SERA will be a highly conservative screening assessment of available media-specific data, used to eliminate contaminants, receptors, and pathways that clearly do not contribute to ecological risks at a site. The SERA will use generic toxicity data from the scientific literature, maximum concentrations of detected chemicals, and conservative exposure assumptions.

The RI/FS Work Plan prepared by the responsible party(ies) will present bioaccumulation factors, toxicity reference values, and indicator receptors to be used in the SERA. During the preparation of the SERA, chemicals potentially present at ambient concentrations (e.g., related to sugar cane cultivation or naturally-occurring metals) will not be screened out of the risk assessment based on a comparison with upwind or upgradient values. Rather, these contaminants will be carried through the risk assessment and discussed in the risk characterization.

If the SERA indicates the potential for risk to ecological receptors, a Baseline Ecological Risk Assessment (BERA) may be warranted according to Steps 3-8 of U.S. EPA guidance (EPA 1997b). The BERA will be a site-specific assessment that is focused on the contaminants, receptors, and pathways identified as potentially contributing to risk in the SERA, incorporating site-specific toxicity data (e.g., bioassays), more complete exposure data (e.g., biological samples in addition to abiotic samples), and more realistic exposure assumptions (e.g., feeding ranges based on feeding home ranges of species occurring on site).

Both the SERA and BERA (if warranted) will contain components common to all ERAs including the following sections:

- Problem Formulation - Task 1.0
- Selection of Chemicals of Potential Ecological Concern - Task 2.0
- Exposure Estimates - Task 3.0
- Effects Evaluation - Task 4.0

- Risk Characterization - Task 5.0
- Uncertainty Analysis - Task 6.0
- Conclusions - Task 7.0

If the SERA indicates the potential for risk, the responsible party(ies) will identify and fill any data gaps as described in Step 3 of U.S. EPA Guidance.

6.5.2 Task 1: Problem Formulation/ Coordination with Natural Resource Trustees

Task 1 will consist of problem formulation. This task includes summarizing information about the environmental setting and contaminant sources, pathways, and ecological receptors.

6.5.2.1 Environmental Setting

This section must summarize onsite and offsite land uses, the aquatic, riparian, and terrestrial habitats in the vicinity of the site, and the habitats that are potentially contaminated or impacted from site releases. This section will need to describe site characteristics such as the cliff, the addition of dredged sediments and fill, and the surface water drainage patterns; including the ponding and sediment deposition associated with the drainage ditch and the areas most likely to drain into Walker Bay. The habitat descriptions will address not only the terrestrial and intertidal zones within the site, but also the adjacent habitats such as Walker Bay. The results of the site reconnaissance must be summarized; and the SERA will include an appendix containing any field notes or reports of a site visit performed by responsible party(ies) or its(their) contractors. Specific components will include:

- Small scale map or figure showing site and surrounding areas
- Large scale map (e.g., 1:24,000 topographic) showing site and surrounding terrestrial and aquatic habitats including major plant communities
- Aerial photograph(s) of site and surrounding areas

6.5.2.2 Contaminants and Other Stressors Associated with the Site

The SERA will summarize historical and current facility operations that may have resulted in environmental releases of chemical and physical stressors. Specifically, the former use of this site by Oahu Sugar as a pesticide and fertilizer mixing and loading area will be noted. This section will include a discussion of source areas. A site description detailing features such as buildings, ASTs, mixing areas, the drainage ditch, and fences will be provided. The SERA will summarize contaminants known or suspected to be present or released from the site. As indicated by previous investigations, dioxins, PCP, other pesticides, herbicides, and metals are site contaminants. Diesel fuel was used as a carrier for herbicides and PAHs may be of concern. Specific components will include:

- Figure showing source areas
- Figures summarizing contaminant data

6.5.2.3 Contaminant/Stressor Fate and Transport

This section will summarize the potential migration pathways of contaminants (e.g., surface water runoff, erosion, groundwater discharge to surface water). Specifically, this section will discuss the potential for contaminants in surface soil to be transported through airborne dust and surface runoff to nearby surface soil, sediment, surface water, and biota. A description of the potential for contaminants in dredge spoils and fill to infiltrate groundwater, discharge to surface water such as Walker Bay and eventually Pearl Harbor, and possibly affect biota will also be included. The maximum detected contaminant concentration measured either onsite or downgradient of the site will be documented for each medium (i.e., surface water, surface sediment, subsurface sediment, groundwater, riparian/bank soil).

The Oahu Sugar SERA will also discuss the Pearl Harbor Sediment Study investigation, and present and analyze the results of samples 3kx, 3ky, and 3kz as they relate to the Oahu Sugar facility.

6.5.2.4 Ecological Receptors

This section will summarize the species and habitats that have been observed or are expected to occur on the site, or are expected to occur in proximity to the site. The description will also summarize any special status species or significant habitats that may occur in or use areas that may be exposed to site releases, including the drainage ditch, Walker Bay, and Pearl Harbor. Ecological receptors that may be exposed to site contaminants and will be discussed in this section include plants, invertebrates, fish, birds, and mammals. Specific components will include:

- List of potential species occurrences in proximity to the site and information sources
- List of special status species and sensitive habitats
- List of communities and guilds evaluated and any communities or guilds excluded from consideration (and justification for exclusion)

6.5.2.5 Conceptual Site Model

This section will describe all potentially complete exposure pathways (e.g., surface soil, groundwater to surface water) and exposure routes (e.g., direct contact and ingestion of prey/food items), and note those that were investigated. Figure 3 provides a preliminary conceptual site model. This model will be refined based on the site reconnaissance and other field tasks. This section will also list all potential exposure pathways and exposure routes that were considered incomplete, and provide justification for any exclusions or omissions.

Specifically, at the Oahu Sugar Site the following ecological receptors will be evaluated for these exposure routes. Plants will be evaluated for exposure to site contaminants through root uptake. Invertebrates will be evaluated for exposure through ingestion of surface soil, sediment, surface water, and biota; and by dermal exposure to sediments and surface water. Fish will be evaluated for potential exposure by ingestion of and dermal exposure to sediment, surface water, and biota. Birds and mammals will be evaluated for exposure to surface soil, sediment, surface water, and biota by ingestion. It is recognized that certain pathways may be assessed qualitatively due to data limitations in the literature.

The SERA will include a CSM showing all possible exposure pathways and exposure routes, whereas the BERA will show a refined CSM based on only those sources, pathways, and receptors that were considered to contribute risk in the SERA.

6.5.2.6 Selection of Assessment and Measurement Endpoints

The ecological risk assessment(s) will discuss the selection of assessment and measurement endpoints for each community or guild. The risk assessor will ensure that any threatened or endangered species (T&E) identified in previous sections are selected as an assessment endpoint. For the SERA, assessment endpoints are any adverse effects on ecological receptors. Ecological receptors for the SERA are plants, animals, and sensitive habitats. For the BERA, assessment endpoints may be refined based on the results of the SERA.

Examples of typical measurement endpoints in a SERA would be a comparison of contaminant concentrations in media (e.g., naphthalene in groundwater) to conservative, but generic ecotoxicity screening values (e.g., ambient water quality criteria). Measurement endpoints in the BERA will be more site-specific. Indicator receptors selected for either the SERA or the BERA will be listed in the RI/FS Work Plan for regulatory review.

6.5.3 Task 2: Selection of Chemicals of Potential Ecological Concern

6.5.3.1 Compile Analytical Data

The responsible party(ies) will review all available analytical data and information on the hazardous constituents to identify the major contaminants of potential ecological concern (COPECs) present at the site. Data will be evaluated and tabulated by medium to indicate the total number of samples, frequency of detection, and range of detected concentrations for each contaminant. These data will include previously collected data from the RI Report prepared by BES and any analytical data collected more recently. If any data are not used, an explanation for why these data are not appropriate for inclusion in the risk assessment will be provided.

6.5.3.2 Compile Screening Benchmarks

Compile readily-available, media-specific ecological benchmarks (i.e., benchmarks associated with surface water, sediment, soil) and chemical- and species-specific toxicity reference values (TRVs) for each contaminant of potential concern and evaluate potential mechanisms of toxicity in the context of possible ecological receptors on the site. Screening values will be no observed adverse effect levels (NOAEL or NOEC) for long-term (chronic) exposures. The TRVs for each contaminant will be used in dose equations to conduct screening-level risk calculation, which will provide a conservative estimate of the potential for adverse ecological effects to occur due to exposure to COPECs.

Tabulate all benchmarks and TRVs, with accompanying rationale for selection of the benchmark to be used in the SERA. The most conservative, relevant benchmark and/or TRV will be selected and the maximum concentration of each chemical will be compared to the appropriate screening benchmark. For examples of potentially appropriate benchmarks, see Tables 3 and 4. A column on the table will indicate the rationale for the elimination or selection of a chemical as a COPEC.

The responsible party(ies) will verify that the detection limit concentration is below its corresponding ecological benchmark concentration. The responsible party(ies) will verify that the reporting limit is below the ecological screening benchmark. In some cases, it may not be feasible to achieve a reporting limit below the benchmark. In these cases, the chemical will be retained for qualitative evaluation.

6.5.4 Task 3: Exposure Evaluation

6.5.4.1 Exposure Media

The Exposure Evaluation section will summarize contaminant concentrations in ecologically relevant media including:

- surface sediment: typically 0 to 0.5 foot depth but dependent on species present
- surface water: entire water column including groundwater with the potential for discharge to surface water
- surface soil: typically 0 to 1 or 2 foot depth but dependent on species present

As discussed below, exposure estimates may differ substantially in a SERA (maximum concentrations, other conservative assumptions) or BERA (mean or upper bound concentrations, site-specific assumptions). Specific components of the Exposure Estimates section will include:

- Figures or maps indicating sample locations in reference to ecologically relevant media (e.g., surface sediment, surface soil, surface water).
- Figures or maps indicating sample identification numbers and locations of samples containing the highest concentration of each contaminant.
- Reference or present a separate table for each medium that lists the following for each analyte: (1) the number of samples; (2) minimum and maximum concentrations (or lowest and highest detection limits for non-detected analytes); (3) the mean and median concentration.

6.5.4.2 Exposure Assumptions

The responsible party(ies) will coordinate with the Natural Resource Trustees (e.g., State of Hawaii, US Fish and Wildlife Service endangered species staff, NOAA) to select exposure parameters (e.g., body weight, home range), as well as other information pertinent to the development of exposure estimates for indicator receptors. The SERA and BERA will provide spreadsheets with food chain modeling and hazard quotient calculations for each indicator receptor.

Measurement endpoints will include comparison of maximum and reasonable maximum exposure concentrations (i.e., 95% Upper Confidence Limit, if available) detected for each receptor through the use of food chain models to simulate the potential trophic transfer of contamination into food resources and subsequent ingestion by representative populations or individuals using the resources at the site. Dose modeling assumptions will be based on readily available exposure factors presented in the U.S. EPA 1993 Wildlife Exposure Factors Handbook (WEFH; available at http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=2799) and commonly accepted allometric equations. Results from the dose modeling will be used to calculate Hazard Quotients (HQs). Similar to the media-specific screening process, HQs will be used as a measurement endpoint to determine whether a contaminant is present at concentrations that may result in adverse impacts to a receptor of concern. For this effort, the chemical- and species-specific no observable adverse effect levels (NOAELs) and the lowest observable adverse effect levels (LOAELs) will be used to estimate a range of possible effects at the site.

6.5.5 Task 4: Effects Evaluation

The responsible party(ies) will relate the measurement endpoints to the assessment endpoints. Any extrapolations that are required to relate the measurement endpoints to the assessment endpoints will be explained (e.g., between species, between individuals and populations, between laboratory and field). Where biological field or bioassay data are collected, an exposure-response relationship will be defined for each contaminant. Limitations of this evaluation will be explained in the uncertainty analysis.

6.5.6 Task 5: Risk Characterization

The responsible party(ies) will provide a discussion of the results of the SERA and BERA, including site-specific exposure estimates, which indicate whether there is the potential for chemical exposures to cause adverse effects to specific ecological receptors using the site or surrounding area. The SERA and BERA will identify the chemicals of concern and areas of the site of greatest concern based on expected use of the site by ecological receptors, and indicate whether there are any remaining data gaps. This section will also include discussion of ambient levels of contamination and associated risks so that risk managers can clearly distinguish the risks resulting from site activities from the ambient risks. The results will provide conclusions and recommendations which will aid risk managers in decision-making when considering whether further evaluation or action is necessary to eliminate, reduce, or control risks to the environment due to contaminants from the site.

6.5.7 Task 6: Uncertainty Analysis

The SERA and BERA will include a discussion of the uncertainties associated with the data set, toxicity information, the conceptual site model, and assumptions used in the estimates of exposures. Sources of uncertainty include those that lead to either an overestimation or underestimation of risk. The direction of the likely error (i.e., over or underestimate) will be reported.

6.5.8 Task 7: Conclusions

The SERA and BERA will contain clearly stated conclusions that can be used in making scientific/management decisions regarding: (1) any imminent threats to ecological receptors, (2) contaminants, pathways, and receptors requiring additional evaluation, and (3) any justification for concluding that no further action is necessary at the site. The information must be sufficient for the risk manager to make one of three decisions: (1) there is adequate information to conclude ecological risks are negligible and there is no need for remediation or corrective action on the basis of ecological risks, (2) there is insufficient information to conclude no further action and additional assessment is needed, or (3) the assessment clearly indicates the presence of ecological risks and the assessment will continue to develop preliminary remediation goals. Specific components will include:

- A table listing all chemicals considered to be COPECs (in the SERA) or chemicals of ecological concern (COECs) (in the BERA) in each media, and the rationale for COPEC inclusions (e.g., no benchmark, HQ > 1) and preliminary remediation goals, if calculated;
- A table listing all chemicals excluded as COPECs (in the SERA) or COECs (BERA) in each media, and the rationale for exclusion (e.g., HQ <

1; metal concentrations that do not exceed background) and preliminary remediation goals, if calculated; and

- A discussion of the most sensitive receptor(s) present at the site according to the results of the ERA, and identification of the chemicals or stressors that drive risk.

6.6 Feasibility Study

6.6.1 Introduction

Planning and execution of the feasibility study begins almost immediately after it is recognized that significant contamination exists at a site. Performance of the feasibility study will be conducted in close concert with the remedial investigation to assure that the RI provides enough data to conduct the FS and that the FS will address contamination identified in the RI. The major tasks associated with the feasibility study are:

- Identify the Remedial Action Objectives
- Identify Potential Remedial Actions, including at least one innovative remedial option
- Assemble Remedial Alternatives
- Perform Treatability Studies (if required)
- Screen Potential Remedial Actions Against the Nine NCP Criteria
- Provide a Preferred Remedy to the RPMs

6.6.2 Remedial Action Objectives

Remedial action objectives (RAOs) consist of medium-specific or operable unit-specific goals for protecting human health and the environment. The objectives will be as specific as possible but not so specific that the range of alternatives that can be developed is unduly limited. RAOs are developed based on the contaminants and media of interest, exposure pathways, and preliminary remediation goals for each contaminated medium. Once the RAOs have been developed, a range of treatment and containment alternatives can be developed to address the contamination. The preliminary remediation goals are developed on the basis of chemical-specific ARARs, when available, other available information (e.g., reference doses), and site-specific risk-related factors.

Examples of generic RAOs include:

- Limit human and ecological exposure to contamination
- Restore groundwater to beneficial use
- Restore the site to unrestricted reuse

- Control the migration of contamination
- Restore surface water quality to National Ambient Water Quality Criteria

Prior to RI/FS Work Plan implementation by the responsible party(ies), the specific RAOs for the Oahu Sugar site cannot be conclusively determined. However, U.S. EPA expects that the RAOs will include:

- Limit human and ecological exposure to contamination
- Restore groundwater to beneficial use (which may not include direct human consumption because of salinity issues) in a reasonable time frame
- Control the migration of contamination in air, surface and groundwater
- Restore surface water quality to the appropriate ecological screening value (e.g., NOAA Lowest Observable Effect Levels, National Ambient Water Quality Criteria, et cetera)

6.6.3 Identify Potential Remedial Actions

Once the preliminary objectives of the remedial action are developed (unless the site poses no risk) the responsible party will develop a preliminary range of remedial action alternatives and associated technologies. This identification is not meant to be a detailed investigation of alternatives. Rather, it is intended to be a more general classification of potential remedial actions based upon the initially identified potential routes of exposure and associated receptors.

The following potential remedial actions will be evaluated during the feasibility study:

- Soil
  - ✓ No Action
  - ✓ Containment
  - ✓ Excavation followed by high temperature thermal desorption
  - ✓ Excavation followed by low-temperature thermal desorption
  - ✓ Excavation followed by offsite disposal
  - ✓ Excavation followed by bioremediation (innovative) - presence of dioxins/furans probably limits the applicability of this alternative
  - ✓ In-situ bioremediation

- Sediments
  - ✓ No Action
  - ✓ In-Situ Capping
  - ✓ Dredging followed by high-temperature thermal desorption
  - ✓ Dredging followed by offsite (upland) disposal
  - ✓ Dredging followed by bioremediation

- Surface Water
  - ✓ No Action
  - ✓ Re-routing of surface water flow across the site
  - ✓ Settling Pond to drop out contaminated sediments

- Groundwater
  - ✓ No Action
  - ✓ Pump and Treat
  - ✓ Enhanced Natural Attenuation (or monitored natural attenuation)

These are the preliminary potential remedial actions. This list is not meant to be complete nor is it likely that all of these remedial actions will be carried forward through the final FS. However, at a minimum, the data collected during the RI must be sufficient to evaluate these potential remedial actions.

6.6.4 Assemble Remedial Alternatives

Because remedial actions for one medium impact contamination in other media (for example, an impervious cap over the soil contamination will change groundwater flow patterns) the potential remedial actions are grouped into remedial alternatives. For example, one remedial alternative might be capping of the soil area, dredging and offsite disposal of contaminated sediment, installing a lined culvert to isolate surface water flow from contaminated soil and monitored natural attenuation for groundwater.

6.6.5 Perform Treatability Studies

Prior to performing an assessment of the assembled remedial alternatives the implementability of some of the potential remedial actions may have to be assessed in treatability studies. Depending on the concentrations of dioxins/furans, bioremediation may be screened out prior to reaching the detailed analysis stage. Proof of performance for low-temperature and high-temperature thermal desorption will probably be required if they pass through the initial screening step.

6.6.6 Screen Potential Remedial Actions Against the Nine NCP Criteria

During the final preparation of the FS report, the assembled remedial alternatives are screened against the nine CERCLA criteria contained in the National Contingency Plan (NCP):

- Protection of Human Health and the Environment
- Satisfaction of ARARs
- Long-term effectiveness and permanence
- Short-Term Effectiveness
- Reduction of Toxicity, Mobility or Volume Through Treatment

- Implementability
- Cost
- Community Acceptance
- State Acceptance

The first two criteria are threshold criteria, the selected remedial alternative must satisfy them. The next five are the primary balancing criteria which are used to rank remedial alternatives that satisfy the threshold criteria. The last two criteria (the modifying criteria) can change the selected remedy, but do not enter into the initial selection process.

6.6.7 Provide a Preferred Remedy to the RPMs

The final product of the FS is an analysis of the various potential remedial actions and an assessment of how they rank. The responsible party(ies) will put forward a preferred remedy to the Regulatory Agencies. The Regulatory Agencies will select a final remedial action for the site which does not have to be the responsible party's(ies') preferred alternative. The Regulatory Agencies may also reject the RI/FS. In the case the RI/FS is rejected, the Regulatory Agencies may order the responsible party(ies) to do more work or may complete the RI/FS themselves.

7.0 REFERENCES

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Tables

Table 1. Rationale for Proposed Sample Locations for the Removal Action and Interim Cover				
Boring Number	**Approximate Location**	**Sample Depths**	**COCs[1]**	**Rationale**
SS25	West of SS06, near fence	surface	Dioxins/Furans	Define western extent of dioxin/furan surface soil contamination
SS26	Approximately 120 feet northwest of SS09, south of SS05	surface	Dioxin/Furans and SVOCs	Define the western extent of dioxin/furan and SVOC surface soil contamination
SS27	Approximately 50 feet east of SS05, between SS05 and SS24	surface	Dioxin/Furans	Identify western edge of dioxin/furan contamination west of the dirt road
SS28	Approximately 60 feet north of SS24, just inside the fence	surface	Dioxin/Furans and Metals	Define the northern extent of dioxin/furan and lead surface soil contamination
SS29	Base of cliff, approximately 90 feet north of SS14	surface	Dioxin/Furans and Pesticides	Define the northern extent of the dioxin/furan and pesticide surface soil contamination near the base of the cliff
SS30	Approximately 60 feet north of SS11, between the cliff and the dirt road	surface	Dioxin/Furans and Pesticides	Define northern extent of dioxin/furan and pesticide contamination on the cliff
SS31	Approximately 60 feet northeast of SS12, just outside fence	surface	SVOCs	Define the eastern extent of SVOC surface soil contamination
SS32	Approximately 40 feet east of SS13, just outside fence	surface	Dioxin/Furan, Metals and SVOCs	Define the eastern extent of dioxin/furan soil contamination and the southeastern extent of the lead and SVOC contamination

Table 1. Rationale for Proposed Sample Locations for the Removal Action and Interim Cover				
Boring Number	**Approximate Location**	**Sample Depths**	**COCs[1]**	**Rationale**
SS33	Approximately 40 feet south of SS13, on cliff, just outside the fence	surface	Dioxin/Furans and SVOCs	Define the southern extent of dioxin/furan and SVOC surface soil contamination.
SS34	Approximately 120 feet south of MW3, at the base of the cliff, just outside the fence	surface	Dioxin/Furans and SVOCs	Define the southern extent of the dioxin/furan and SVOC soil contamination and provide groundwater data downgradient of the site
SS35	Approximately 60 feet southwest of MW-02, just outside the fence	surface	Dioxin/Furans	Define the southern extent of the dioxin/furan surface soil contamination
SS36	Approximately 60 feet south of SS06, outside the fence	surface	Dioxin/Furans	Define the southern extent of the dioxin/furan surface soil contamination
SS37	South of the site, in drainage ditch, south of the fence.	surface soil/ sediment	Dioxin/Furans, SVOCs, metals, pesticides	Define the surface soil/sediment contamination in the drainage ditch and determine if contaminated sediment is moving downstream in the ditch.

[1] The analytical method used by BES to evaluate herbicides would not detect atrazine, simazine, paraquat or diquat, all herbicides known to have been used in the cultivation of sugarcane. Atrazine is reported to have accounted for up to 50% of all the herbicides used on sugar cane fields in Hawaii (see http://www.environment-hawaii.org/696atra.htm). Therefore, all soil samples collected will be analyzed for these contaminants of potential concern.

bgs = below ground surface
COCs = contaminants of concern
SS = surface sample
SVOCs = semi-volatile organic compounds

Table 2. Analytical Methods for the Removal Action			
Matrix	**COCs**	**Analysis**	**Number of Analyses[1]**
Soil and Sediment	Dioxin/Furans	EPA 8290	13
	SVOCs	EPA 8270C	6
	Metals	EPA 6010	3
	Organochlorine pesticides	EPA 8081A	3
	Diquat/Paraquat[2]	EPA 549.2	13
	Atrazine Family[2]	EPA 8141A	13

[1] Does not include duplicate samples or quality control samples. Does not include step-out samples or1 confirmation samples to be collected from the cliff. Confirmation samples from the cliff will be analyzed for all COCs.

[2] The analytical method used by BES to evaluate herbicides would not detect atrazine, simazine, paraquat or diquat, all herbicides known to have been used in the cultivation of sugarcane. Atrazine is reported to have accounted for up to 50% of all the herbicides used on sugar cane fields in Hawaii (see http://www.environment-hawaii.org/696atra.htm). Therefore, all samples will be analyzed for these potential contaminants of concern.

COCs = contaminants of concern
SVOCs = semi-volatile organic compounds

Table 3. Target Reporting Limits for Inorganics

Chemical	Upland Soil (mg/kg)	Freshwater Sediment (mg/kg)	Marine Sediment (mg/kg)	Groundwater and Surface Water (µg/L)
Antimony	21	2	2	30
Arsenic	37	9.79	8.2	36
Beryllium	10	NA	NA	0.66
Cadmium	29	0.99	1.2	0.25
Chromium	5	43.4	81	74
Copper	61	31.6	34	3.1
Lead	50	35.8	46.7	2.5
Mercury	0.1	0.18	0.15	0.77
Nickel	30	22.7	20.9	8.2
Selenium	1	NA	NA	0.005
Silver	2	1	1	0.00036
Thallium	1	NA	NA	0.01
Zinc	50	121	150	0.12

NA = benchmark not available

Table 4. Target Reporting Limits for Organics					
	Chemical	**Soil (mg/kg)**	**Freshwater Sediment (mg/kg)**	**Marine Sediment (mg/kg)**	**Groundwater and Surface Water (mg/L)**
Dioxins/Furans					
	2,3,7,8-TCDD	NA	8.8E-06	3.6E-06	1.E-08
Organochlorine Pesticides					
	alpha-BHC	0.0025	0.006	0.006	0.0022
	gamma-BHC (lindane)	0.00005	0.00237	0.0037	NA
	total chlordane	0.00003	0.00324	0.0005	4.30E-06
	Total DDT	0.0025	0.00528	0.00158	0.000001
	Total Endosulfan ($\alpha + \beta$)	0.00001	NA	0.0054	0.000056
	Dieldrin	0.01	0.0019	0.00002	0.000056
Chlorinated Herbicides					
	2,4-D	NA	NA	NA	NA
	2,4-DB	NA	NA	NA	NA
	2,4,5-TP (Silvex)	NA	NA	NA	NA
	Dalapon	NA	NA	NA	NA
	Dinoseb	NA	NA	NA	NA
Semivolatile Organic Chemicals					
	Acenaphthene	20	0.33	0.04	NA
	Acenaphthalyene	NA	0.33	0.01	NA
	Anthracene	0.1	0.05	0.08	0.00073
	Benzo(a)anthracene	NA	NA	NA	NA

	Table 4. Target Reporting Limits for Organics				
	Chemical	**Soil (mg/kg)**	**Freshwater Sediment (mg/kg)**	**Marine Sediment (mg/kg)**	**Groundwater and Surface Water (mg/L)**
	Benzo(b)fluoranthene	NA	0.02	NA	NA
	Benzo(ghi)perylene	NA	0.29	31	NA
	Benzo(a)pyrene	0.1	0.15	0.43	0.000014
	Carbazole	NA	NA	NA	NA
	4-Chloroaniline	0.005	NA	NA	NA
	Chrysene	NA	0.16	0.38	NA
	Dibenz(a,h)anthracene	NA	0.03	0.06	NA
	Dibenzofuran	NA	NA	15	0.0037
	Di-n-butyl phthalate	200	NA	61	0.03
	Fluoranthene	0.1	0.42	0.6	NA
	Fluorene	30	0.07	0.01	0.0039
	Hexachlorobenzene	0.0025	0.02	0.38	NA
	Indeno(1,2,3-cd)pyrene	NA	0.07	34	NA
	Naphthalene	0.1	0.17	0.16	0.01
	Pentachlorophenol	3	NA	0.36	0.01
	Phenanthrene	0.1	0.2	0.24	NA
	Pyrene **Other Herbicides**	0.1	0.19	0.66	NA
	Atrazine	0.33			
	Simazine	0.33			
	Paraquat	5			
	Diquat	5			
NA	= benchmark not available				

Table 5. Interim Cover Cost Estimates					
COVER ALTERNATIVE	**Pervious**	**Mainten-ance Cost**	**Lifecycle Cost (1000s)**	**Advantages**	**Disadvantages**
Subtitle D - 2 feet of clay with a geomembrane and vegetative layer - assumes 850 tons of bentonite imported to Hawaii for soil amendment	No	High	$810	High public acceptance, may serve as final remedy	Expensive, high maintenance, will probably result in additional contaminated material requiring disposal
Dust Barrier - Geotextile separator with 6 inches of gravel	Yes	Low	$77	Inexpensive	Pervious to water; might not be acceptable to public
Asphalt- 3 inch thick standard asphaltic concrete	No	Low	$510		Expensive; will produce approximately 3700 tons of waste that may be contaminated; not as impervious as the GCL or HDPE membrane alternatives
Geocomposite Liner - Geotextile with bentonite	No	Low	$160	Inexpensive.	Once the bentonite becomes saturated, it may be difficult to remove it
Geocomposite Liner - Geomembrane with bentonite, one-foot vegetative layer - essentially a Subtitle D equivalent	No	Low	$380	May serve as final remedy	Once the bentonite becomes saturated, it may be difficult to remove it

Table 5. Interim Cover Cost Estimates					
COVER ALTERNATIVE	**Pervious**	**Mainten-ance Cost**	**Lifecycle Cost (1000s)**	**Advantages**	**Disadvantages**
High Density Polyethylene Membrane- HDPE membrane overlies 16 oz cushion geotexile with 6 inches of gravel for ultraviolet protection	No	Low	$200		
Biosolids - 12 inches of sewage treatment plant solids - - see assumption 10	Yes	High	$540	High organic carbon content may fix contaminants	Greatly increased disposal costs; the biosolids would probably not pass a paint filter test, which may be an issue

Table 6. Unit Costs	
Item	**Unit Cost**
Non Woven Geotextile (8 oz)	$0.20/ft^2
Non Woven Geotextile (16 oz)	$0.25/ft^2
GCL (bentonite geotextile)	$0.55/ft^2
GCL (bentonite geomembrane)	$0.80/ft^2
HDPE Geomembrane	$0.50/ft^2
Gravel	$12/yd^3
Asphalt	$65/ton
Soil (general fill)	$10/yd^3
Bentonite (includes shipping @ $30/ton)	$180/ton

Source: RS Means Cost Estimating, the cost estimate prepared by Friesen and Associates for the New South Hilo Landfill (included in the October 2003 Environmental Impact Statement for the Hawaii County Sorting Station), and judgement where necessary.

Table 7 Rationale for Proposed Sample Locations for the RI/FS			
Approximate Location	**Sample Depths and Media**	**COCs**	**Rationale**
Approximately 30 feet from perimeter of interim cover, or where contaminant concentrations exceed ND in previous sample locations	surface and subsurface	Dioxins/Furans, SVOCs, metals, pesticides, atrazine, simazine, paraquat, diquat	Define extent of contamination to ND or ecological screening levels. Sample locations will be determined based on results of the limited investigation conducted to install the interim cover and previous sample locations from the RI. Surface and subsurface samples will be collected. In addition, subsurface soil samples will be collected through the cover, below the known contamination, to define the vertical extent of contamination to ND.
Approximately 30 feet from excavated area above cliff, or where contaminant concentrations exceed ND or ecological screening levels in previous sample locations (e.g., 04, 01)	surface and subsurface	Dioxins/Furans, SVOCs, metals, pesticides, atrazine, simazine, paraquat, diquat	Define extent of contamination to ND or ecological screening levels.
North and south of the interim cover within the drainage ditch	surface, subsurface, and sediment	Dioxins/Furans, SVOCs, metals, pesticides, atrazine, simazine, paraquat, diquat	Define the lateral and vertical extent of contamination in the drainage ditch, north and south of the site. At a minimum, a sample should be collected in the ditch north of the site boundaries, and south of the sediment sample collected during the limited investigation to install the cover. The data will be used to support development of sediment exposure point concentrations.

Table 7
Rationale for Proposed Sample Locations for the RI/FS

Approximate Location	Sample Depths and Media	COCs	Rationale
Outfall of drainage ditch in Pearl Harbor.	surface sediment	Dioxins/Furans, SVOCs, metals, pesticides, atrazine, simazine, paraquat, diquat	Define the presence or absence of sediment contamination in Pearl Harbor at outfall of drainage ditch. Support development of sediment exposure point concentrations.
Walker Bay, along the western site boundary	surface sediment	Dioxins/Furans, SVOCs, metals, pesticides, atrazine, simazine, paraquat, diquat	Contaminants that were detected in surface soil at Oahu Sugar Site were also detected in sediment in Walker Bay during the Step 7 investigation conducted by the Navy (US Navy, 2004). The purpose of the sampling is to establish if site-related contaminants have impacted Walker Bay, and to support calculation of exposure point concentrations.
End of the former runway	surface and subsurface soil	Dioxin/Furans, SVOCs, metals, pesticides, atrazine, simazine, paraquat, diquat	Aircraft cleaning and pesticide loading are often conducted at the end of the runway at a pesticide mixing site. Establish sample locations based on site reconnaissance and site history.
MW-4	surface and subsurface soil and groundwater	Dioxin/Furans, metals, SVOCs, pesticides, and atrazine, simazine, paraquat, diquat	MW-4 should be installed just south of the site, near the cliff This location provides a groundwater elevation to further refine the groundwater gradient south of the facility.

Table 7 Rationale for Proposed Sample Locations for the RI/FS			
Approximate Location	**Sample Depths and Media**	**COCs**	**Rationale**
MW-5	surface and subsurface soil and groundwater	Dioxin/Furans, metals, SVOCs, pesticides, and atrazine, simazine, paraquat, diquat	MW-5 should be installed approximately 10 feet east of the dirt road bisecting the center portion of the facility (approximately 60 feet west of former sample 20) along a line connecting former sampling locations 09 and 20. This location will provide information regarding: (1) the magnitude of groundwater fluctuations (if any) resulting from tidal influences in Walker Bay, (2) the groundwater elevation in the central portion of the facility to further refine the groundwater gradient, and (3) whether contaminated groundwater from the former Mixing Area is migrating to the west.
MW-6	surface and subsurface soil and groundwater	Dioxin/Furans, metals, SVOCs, pesticides, and atrazine, simazine, paraquat, diquat	MW-6 should be installed approximately 60 feet northwest of sampling location SS28. This location will serve as a background location if it is confirmed that groundwater flows to the south. This location also provides a groundwater elevation (presumably not influenced by tidal activity) to further refine the groundwater gradient north of the facility.

Table 7 Rationale for Proposed Sample Locations for the RI/FS			
Approximate Location	**Sample Depths and Media**	**COCs**	**Rationale**
MW-7	surface and subsurface soil and groundwater	Dioxin/Furans, metals, SVOCs, pesticides, and atrazine, simazine, paraquat, diquat	MW-7 should be installed approximately 25 feet north of sample location SS30. This location will serve as a background location if it is determined (via the tidal investigation discussed below) that the groundwater flows to the west or has a westerly component. This location also provides a groundwater elevation to further refine the groundwater gradient east of the facility.
MW-8	surface and subsurface soil and groundwater	Dioxin/Furans, metals, SVOCs, pesticides, and atrazine, simazine, paraquat, diquat	MW-8 should be installed directly adjacent to, and along the west bank of the Drainage Ditch approximately 40 feet south of sample location SS37. This location will provide information regarding the hydraulic interaction between the Drainage Ditch and the underlying groundwater (if any). This location also provides a groundwater elevation to further refine the groundwater gradient south of the facility, and provides information regarding the magnitude of tidal influence from Walker Bay.

bgs = below ground surface
COCs = contaminants of concern
FS = Feasibility Study
MW = monitoring well
RI = remedial investigation
SB = soil boring
SVOCs = semi-volatile organic compounds

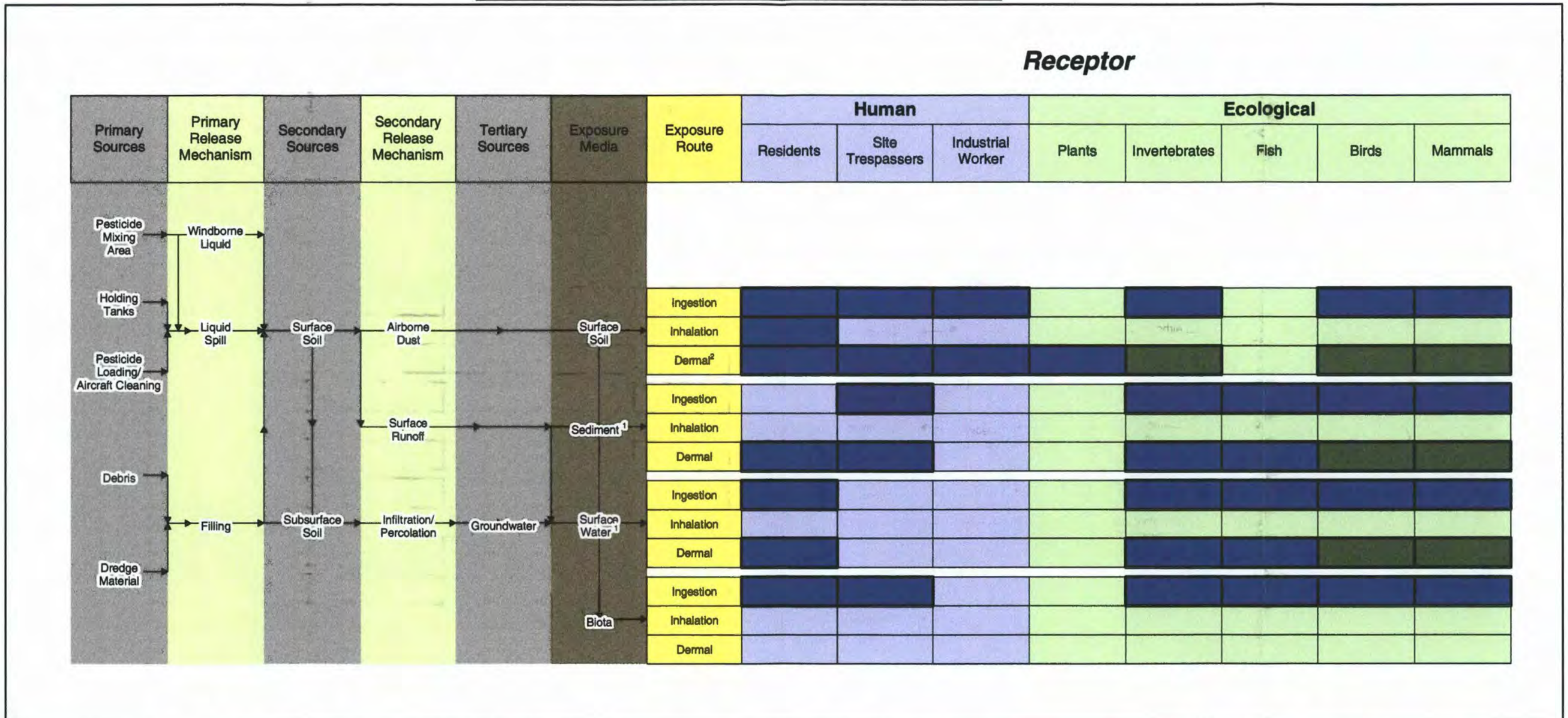
Table 8. Analytical Methods for the RI/FS		
Matrix	**COCs**	**Analysis**
Soil and sediment	Dioxin/Furans SVOCs Metals Organochlorine pesticides Diquat/Paraquat Atrazine Family	EPA 8290 EPA 8270C EPA 6010 EPA 8081A EPA 549.2 EPA 8141A
Groundwater**	Dioxin/Furans SVOCs Metals Organochlorine pesticides Diquat/Paraquate Atrazine Family	EPA 8290 EPA 8270C EPA 6010 EPA 8081A EPA 549.2 EPA 8141A

** It is recommended that both filtered and unfiltered groundwater samples be collected.

COCs = contaminants of concern
RI/FS = Remedial Investigation/Feasibility Study
SVOCs = semi-volatile organic compounds

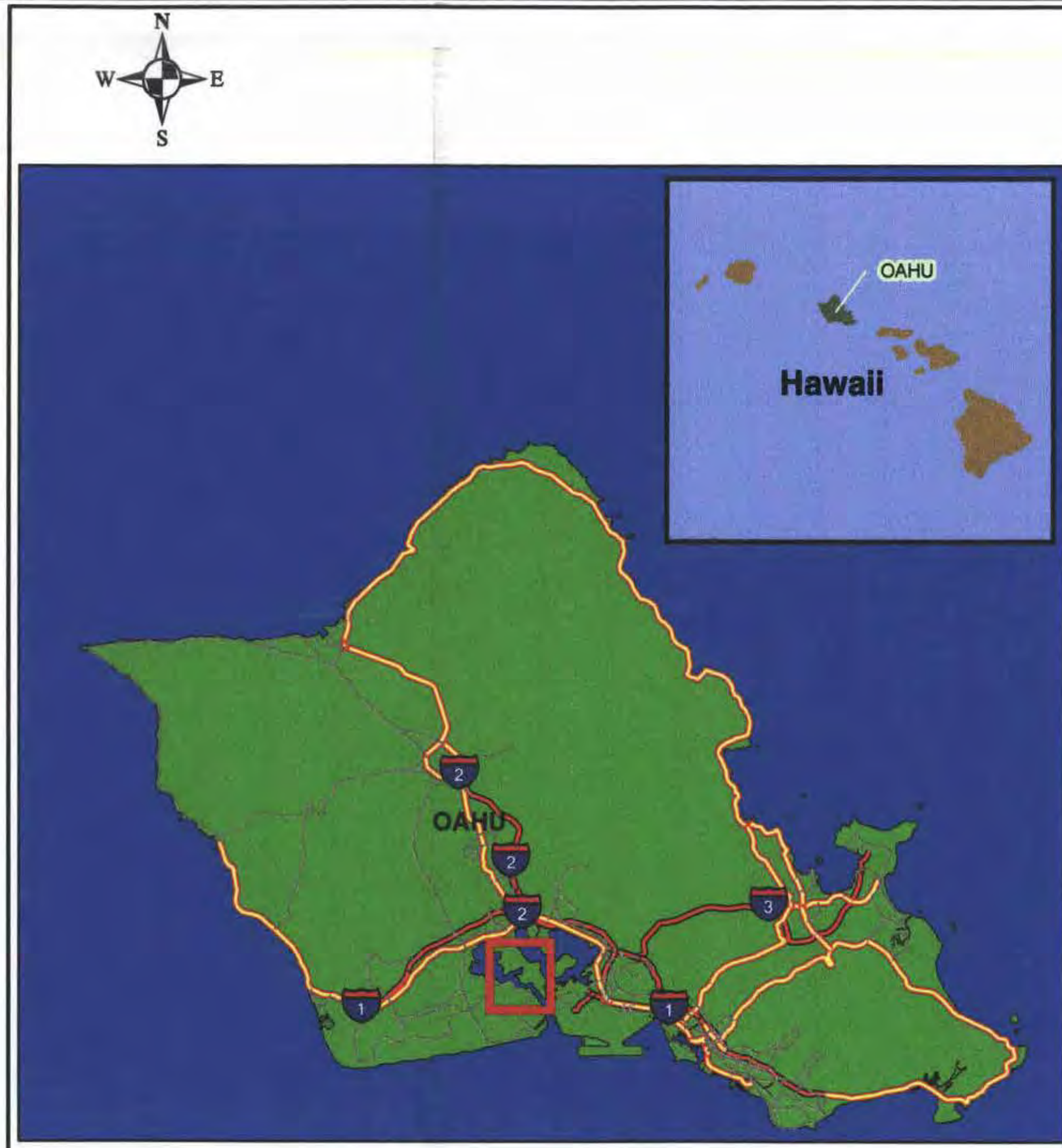
Figures

Figure 7
Conceptual Site Model for Human Health and Ecological Risk
Waipio Peninsula Remedial Investigation
Waipahu, Oahu, Hawaii



Footnote:
1. Sediment and surface water in both the drainage channel and Pearl Harbor are exposure media. However each should be considered separately for exposure and remedies.
2. In the case of plants, "Dermal" refers to root uptake.

Sources		Exposure Route		Completed exposure pathway to be evaluated quantitatively	
Mechanisms		Human Receptor		Potentially completed exposure pathway to be evaluated qualitatively	
Exposure Media		Ecological Receptor			



10 5 0 10 Kilometers

10 5 0 10 Miles

Figure 1
Site Location
Oahu Sugar Site, Waipio Peninsula
Waipahu, Oahu, Hawaii

0.5 0.25 0 0.5 Kilometers

0.5 0.25 0 0.5 Miles

150 75 0 150 Meters

400 200 0 400 Feet

Figure 1A
Site Location Aerial Photograph
Oahu Sugar Site, Waipio Peninsula
Waipahu, Oahu, Hawaii

N W E S

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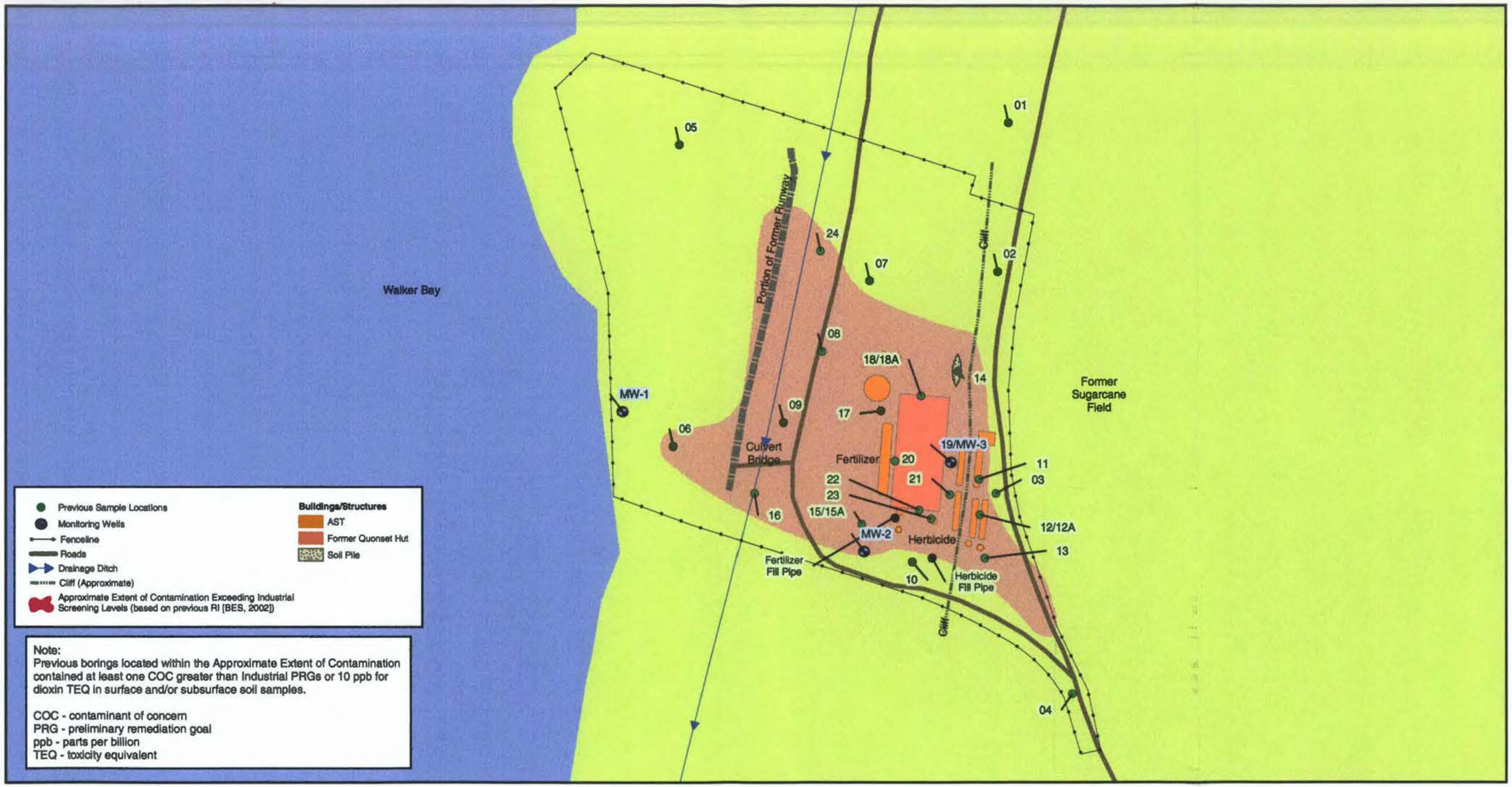

25 12.5 0 25 Meters

100 50 0 100 Feet

Figure 2
Site Features and Previous Sample Locations
Oahu Sugar Site, Waipio Peninsula
Waipahu, Oahu, Hawaii

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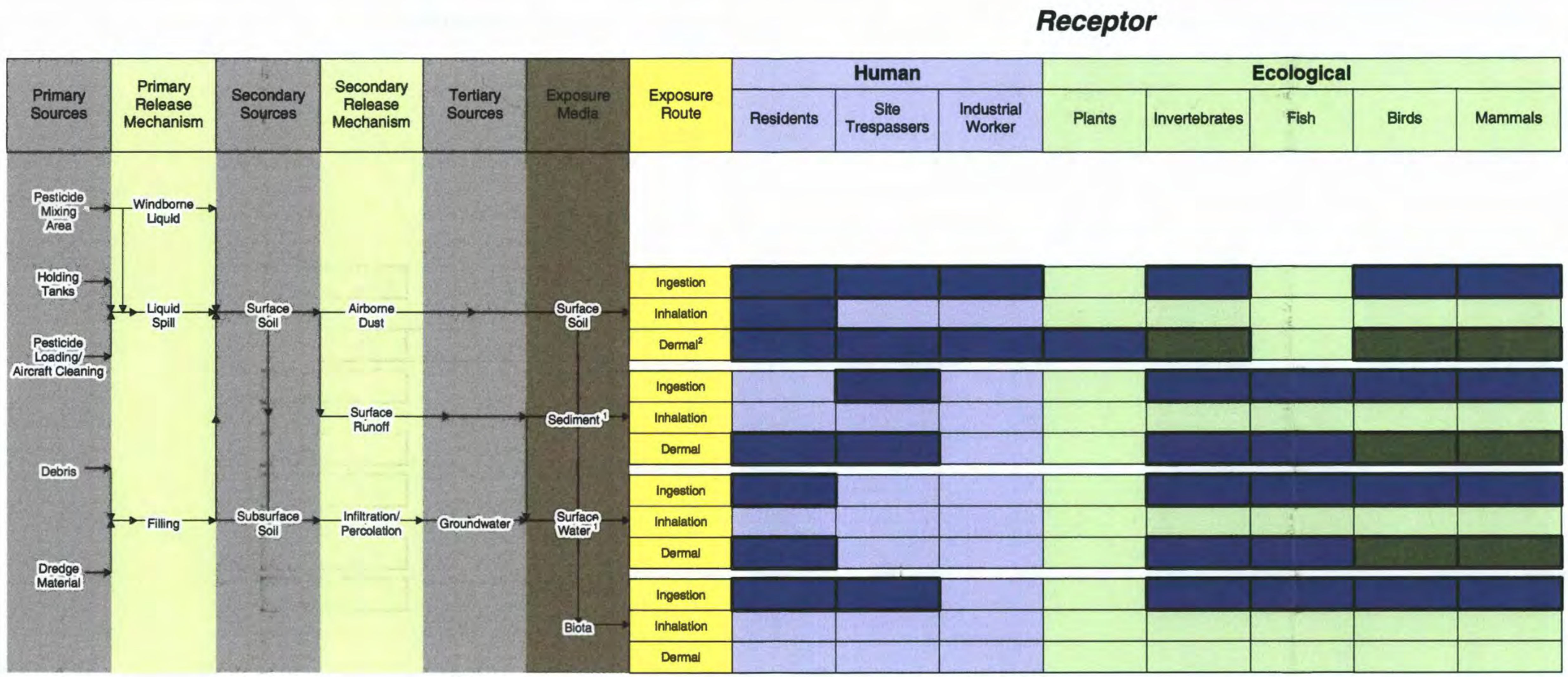
Figure 3
Conceptual Site Model for Human Health and Ecological Risk
Oahu Sugar Site, Waipio Peninsula
Waipahu, Oahu, Hawaii



Footnote:
1. Sediment and surface water in both the drainage channel and Pearl Harbor are exposure media. However each should be considered separately for exposure and remedies.
2. In the case of plants, "Dermal" refers to root uptake.

Sources	Exposure Route	Completed exposure pathway to be evaluated quantitatively
Mechanisms	Human Receptor	Potentially completed exposure pathway to be evaluated qualitatively
Exposure Media	Ecological Receptor	

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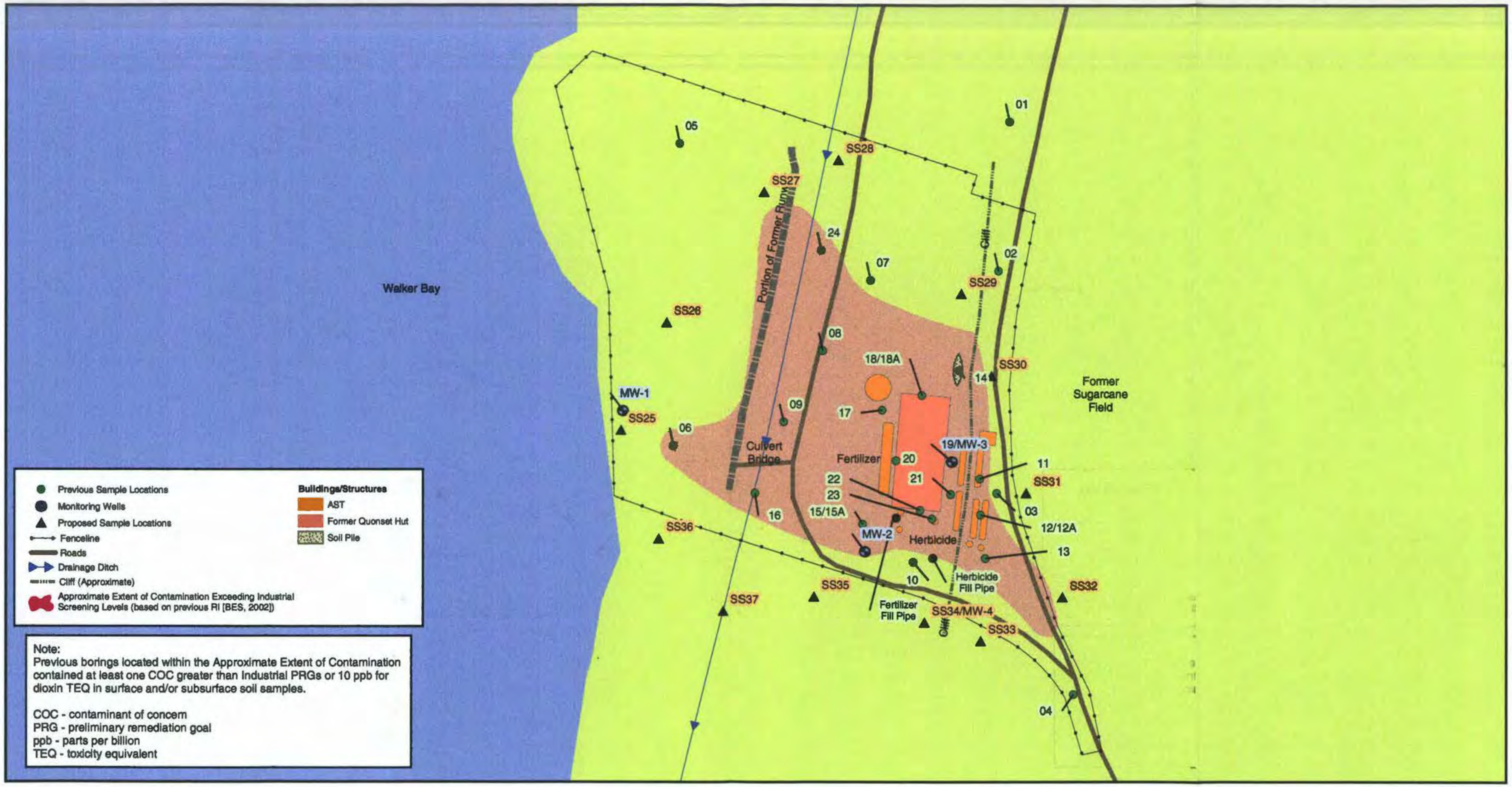

25 12.5 0 25 Meters

100 50 0 100 Feet

Figure 4
Proposed Sample Locations
Oahu Sugar Site, Waipio Peninsula
Waipahu, Oahu, Hawaii

N W E S

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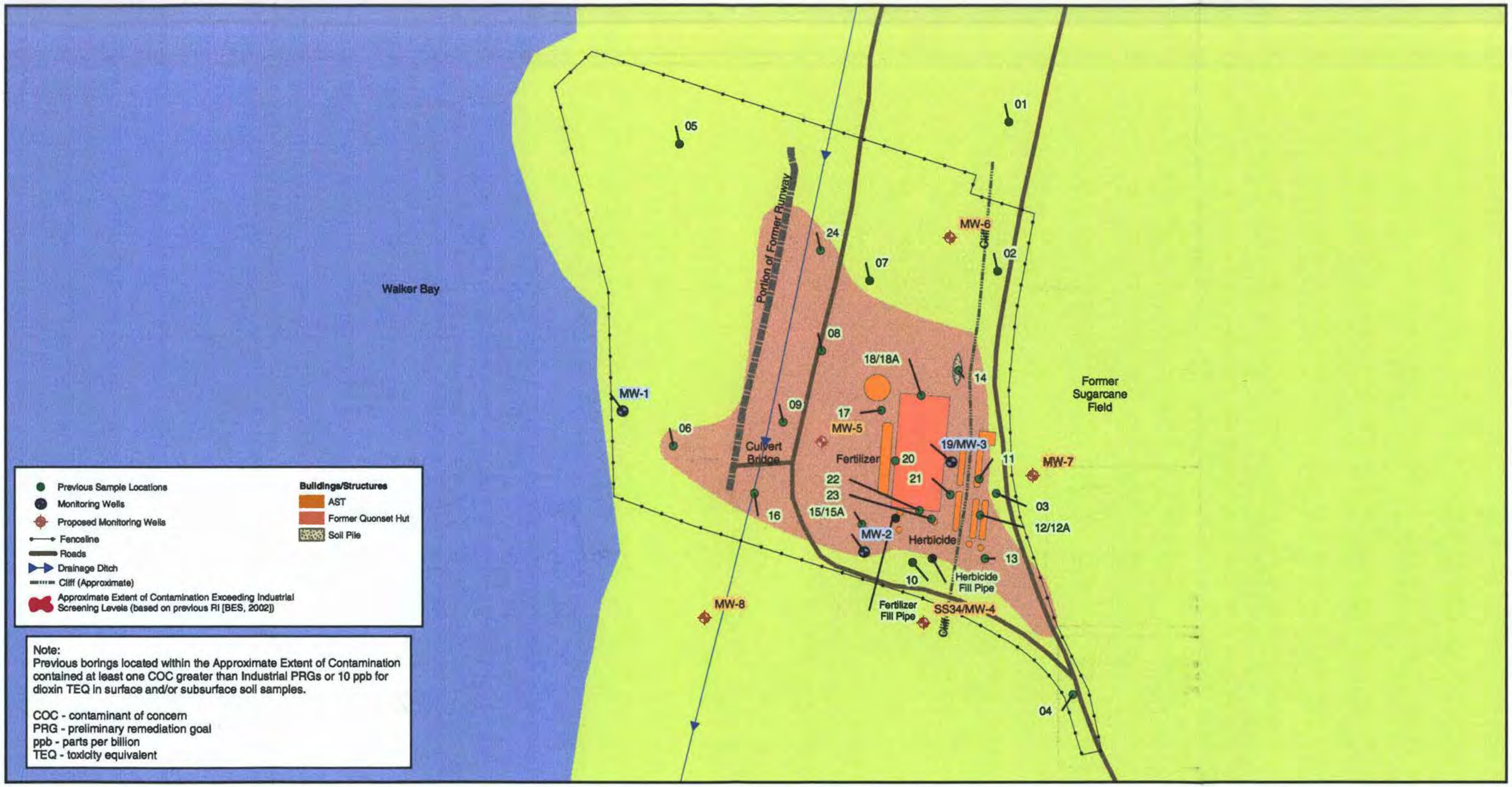

Figure 5
Proposed Monitoring Well Locations
Oahu Sugar Site, Waipio Peninsula
Waipahu, Oahu, Hawaii

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